MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
(Deemed to be University)
MADANAPALLE
www.mits.ac.in

DEPARTMENT OF MECHANICAL ENGINEERING
Course Structure
&
Detailed Syllabi

For the students admitted to

B. Tech. Regular Four Year Degree Programme during the Academic Year 2025-26

and

B. Tech. Lateral Entry Scheme during the Academic Year 2026-27

DEPARTMENT OF MECHANICAL ENGINEERING

MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE

(Deemed to be University)

MADANAPALLE

B. Tech Four Year Curriculum Structure

Branch: MECHANICAL ENGINEERING

Total Credits	160 Credits for 2025 (Regular) & 120 Credits for 2026 (Lateral Entry) Admitted Batch onwards

I. Induction Program and Holistic Development Activities

Sl.No	Title	Duration
1	Induction Program (Mandatory)	Three weeks' duration at the start of First Year

R25 - Curriculum Structure
I Year I Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	AEC	25BAENGTC01	Professional Communication	2	0	0	2	2
2	HSMC	25BAHUMTC01	Human Values and Professional Ethics	2	0	0	2	2
3	BSC	25BAMATTC01	Engineering Calculus	3	0	0	3	3
4	BSC	25BAPHYTC01	Engineering Physics	3	0	0	3	3
5	ESC	25BACAITC02	Foundations of Artificial Intelligence	2	0	0	2	2
6	PCC	25BAMECTC01	Materials Science for Engineers	3	0	0	3	3
7	AEC	25BAENGLC01	Professional Communication Laboratory	0	0	2	2	1
8	BSC	25BAPHYLC01	Physics Laboratory	0	0	2	2	1
9	ESC	25BACSELC04	Problem Solving using Python Laboratory	0	0	4	4	2
10	ESC	25BACOMLC01	Engineering Skills Laboratory	0	0	2	2	1
Total				**15**	**0**	**10**	**25**	**20**

I Year II Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	BSC	25BAMATTC03	Linear Algebra and Differential Equations	3	0	0	3	3
2	BSC	25BACHETC01	Engineering Chemistry	3	0	0	3	3
3	ESC	25BACIVTC02	Introduction to Environment and Sustainability	2	0	0	2	2
4	ESC	25BAEEETC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
5	ESC	25BAMECTC02	Engineering Mechanics	2	1	0	3	3
6	ESC	25BAMECEC01	Engineering Graphics	2	0	2	4	3
7	BSC	25BACHELC01	Engineering Chemistry Laboratory	0	0	2	2	1
8	ESC	25BAEEELC01	Basic Electrical and Electronics Engineering Laboratory	0	0	2	2	1
9	ESC	25BACOMLC02	Scientific Computing Laboratory	0	0	2	2	1
Total				**15**	**1**	**8**	**24**	**20**

(L = Lecture, T = Tutorial, P = Practical, C = Credit

R25 - Curriculum Structure

II Year I Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	BSC	25BAMATTC06	Probability and Statistics for Engineers	3	0	0	3	3
2	ESC	25BAMECTC03	Engineering Thermodynamics	2	1	0	3	3
3	PCC	25BAMECTC04	Product Design and Development	3	0	0	3	3
4	PCC	25BAMECTC05	Mechanics of Solids	2	1	0	3	3
5	PCC	25BAMECTC06	Manufacturing Processes	3	0	0	3	3
6	PCC	25BAMECLC01	Mechanics of Solids and Materials Science Laboratory	0	0	2	2	1
7	PCC	25BAMECLC02	Manufacturing Processes Laboratory	0	0	2	2	1
8	PCC	25BAMECLC03	Computer Aided Machine Drawing Laboratory	0	0	2	2	1
9	SEC		**Skill Enhancement Course – I** *(Refer ANNEXURE - IV)*	1	0	2	3	2
10	EEC		**NSDC - Certification Course – I** *(Refer ANNEXURE - V)*	0	0	2	2	-
Total				**14**	**2**	**10**	**26**	**20**

II Year II Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	BSC	25BAMATTC10	Numerical Methods	3	0	0	3	3
2	PCC	25BAMECTC07	Machine Tools and Metrology	3	0	0	3	3
3	PCC	25BAMECTC08	Fluid Mechanics and Hydraulic Machines	2	1	0	3	3
4	PCC	25BAMECTC09	Theory of Machines	2	1	0	3	3
5	OE		**Open Elective – I** *(Refer ANNEXURE - II)*	3	0	0	3	3
6	PCC	25BAMECLC04	Machine Tools and Metrology Laboratory	0	0	2	2	1
7	PCC	25BAMECLC05	Fluid Mechanics and Hydraulic Machines Laboratory	0	0	2	2	1
8	PCC	25BAMECLC06	Dynamics and Vibration Analysis Laboratory	0	0	2	2	1
9	SEC		**Skill Enhancement Course – II** *(Refer ANNEXURE - IV)*	1	0	2	3	2
10	EEC		**NSDC - Certification Course – II** *(Refer ANNEXURE - V)*	0	0	2	2	-
Total				**14**	**2**	**10**	**26**	**20**

(L = Lecture, T = Tutorial, P = Practical, C = Credit

R25 – Tentative Curriculum Structure

III Year I Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	HSMC		Entrepreneurship Venture	3	0	0	3	3
2	PCC	25BAMECTC10	Design of Machine Elements	2	1	0	3	3
3	PCC	25BAMECTC11	Heat Transfer	2	1	0	3	3
4	DE		**Discipline Elective – I** *(Refer ANNEXURE - III)*	3	0	0	3	3
5	OE		**Open Elective – II** *(Refer ANNEXURE - II)*	3	0	0	3	3
6	PCC	25BAMECLC07	Heat Transfer Laboratory	0	0	2	2	1
7	PCC	25BAMECLC08	Automation and Robotics Laboratory	0	0	2	2	1
8	SEC		**Skill Enhancement Course – III** *(Refer ANNEXURE - IV)*	1	0	2	3	2
9	INT	25BAMECIC01	Summer Internship - I	0	0	2	2	1
10	EEC		**NSDC - Certification Course – III** *(Refer ANNEXURE - V)*	0	0	2	2	-
Total				**16**	**0**	**10**	**26**	**20**

III Year II Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	HSMC		Operations Research and Project Management	3	0	0	3	3
2	PCC	25BAMECTC12	Electric Vehicles and Battery Management	2	0	0	2	2
3	PCC	25BAMECTC13	Thermal Engineering	2	1	0	3	3
4	PCC	25BAMECTC14	Mechatronics	2	0	0	2	2
5	DE		**Discipline Elective – II** *(Refer ANNEXURE - III)*	3	0	0	3	3
6	OE		**Open Elective – III** *(Refer ANNEXURE - II)*	3	0	0	3	3
7	PCC	25BAMECLC09	Thermal Engineering Laboratory	0	0	2	2	1
8	PCC	25BAMECLC10	Mechatronics Laboratory	0	0	2	2	1
9	AEC	25BAENGEC01	Soft Skills (Career Essentials)	1	0	2	3	2
10	EEC		**NSDC - Certification Course – IV** *(Refer ANNEXURE - V)*	0	0	2	2	-
Total				**16**	**1**	**8**	**25**	**20**

(L = Lecture, T = Tutorial, P = Practical, C = Credit

R25 - Tentative Curriculum Structure
IV Year I Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PCC	25BAMECTC15	Smart Manufacturing and Industry 4.0 Systems	3	0	0	3	3
2	PCC	25BAMECTC16	Engineering Analysis	2	1	0	3	3
3	DE		**Discipline Elective – III** *(Refer ANNEXURE - III)*	3	0	0	3	3
4	DE		**Discipline Elective – IV** *(Refer ANNEXURE - III)*	3	0	0	3	3
5	DE		**Discipline Elective – V** *(Refer ANNEXURE - III)*	3	0	0	3	3
6	OE		**Open Elective – IV** *(Refer ANNEXURE - II)*	3	0	0	3	3
7	PCC	25BAMECLC11	Computer Aided Engineering Analysis Laboratory	0	0	2	2	1
8	SEC		**Skill Enhancement Course – IV** *(Refer ANNEXURE – IV)*	1	0	2	3	2
9	INT	25BAMECIC02	Summer Internship - II	0	0	4	4	2
10	EEC		**NSDC - Certification Course – V** *(Refer ANNEXURE - V)*	0	0	2	2	-
Total				**19**	**0**	**10**	**29**	**23**

IV Year II Semester

S. No.	Category	Course Code	Course Title	Hours Per Week				Credits
				L	T	P	Total	
1	PW	25BAMECPC01	Capstone Project	0	0	28	28	14
2	INT	25BAMECIC03	Full Semester Internship	0	0	6	6	3
Total				**0**	**0**	**34**	**34**	**17**

(L = Lecture, T = Tutorial, P = Practical, C = Credit

ANNEXURE - I

THREE WEEK MANDATORY INDUCTION PROGRAMME

- Yoga and Meditation
- Sports and Games
- NSS
- NCC
- MITS Social Responsibility Club
- Management module
- Design Thinking
- Spoken and Written Communication

- ***Proficiency modules***

  - Basic Computer Proficiency
  - Interpersonal skills
  - Computer Graphics
  - Web programming
  - Mobile Apps
  - Vocabulary enhancement

HOLISTIC DEVELOPMENT ACTIVITIES

Description of Activities

1. Universal Human Values (UHV – I)
2. Physical and Health
3. Culture
4. Literature and Media
5. Social Service
6. Self-Development
7. Nature and Environment
8. Innovation

ANNEXURE - II

OPEN ELECTIVE – I

(To be offered under MOOC's Category from SWAYAM – NPTEL) – **II Year II Semester**

Sl. No.	Course Code	Course Title	Course Offered by Department of
1	25BAHUMOM01	English Language for Competitive Exams	Humanities and Social Sciences
2	25BAHUMOM02	Public Speaking	Humanities and Social Sciences
3	25BAHUMOM03	Indian Business History	Humanities and Social Sciences
4	25BAHUMOM04	Indian Economy: Some Contemporary Perspectives	Humanities and Social Sciences
5	25BAMBAOM01	E – Business	Management
6	25BAMBAOM02	AI in Human Resource Management	Management
7	25BAMBAOM03	AI in Marketing	Management
8	25BAMBAOM04	Artificial Intelligence for Investments	Management
9	25BACIVOM01	Plastic Waste Management	Civil
10	25BACIVOM02	Safety in Construction	Civil
11	25BAEEEOM01	Transducers For Instrumentation	EEE
12	25BAECEOM01	Microprocessors and Interfacing	ECE
13	25BAECEOM02	Microprocessors and Microcontrollers	ECE
14	25BACSEOM01	Privacy and Security in Online Social Media	CSE
15	25BACSEOM02	Computer Networks and Internet Protocol	CSE
16	25BACSEOM03	Introduction to Soft Computing	CSE
17	25BACSEOM04	Human Computer Interaction (in Hindi)	CSE
18	25BACOMOM01	Research Methodology	Multidisciplinary
19	25BACOMOM02	Fuzzy Logic and Neural Networks	Multidisciplinary

Any new Interdisciplinary Course offered by SWAYAM NPTEL can be appended in future.

ANNEXURE – III

LIST OF DISCIPLINE ELECTIVES

Discipline Elective – I (To be offered under MOOC's Category from SWAYAM – NPTEL)		
S. No.	**Course Code**	**Course Title**
1.	25BAMECDM01	Laser Based Manufacturing
2.	25BAMECDM02	Rapid Manufacturing
3.	25BAMECDM03	Introduction to Robotics
4.	25BAMECDM04	Fundamental of Welding Science and Technology
5.	25BAMECDM05	Introduction to Machining and Machining Fluids
Any advanced Course offered by SWAYAM NPTEL can be appended in future.		

Discipline Elective – II		
S. No.	**Course Code**	**Course Title**
1.	25BAMECDC01	Refrigeration and Air Conditioning
2.	25BAMECDC02	Renewable Energy Systems
3.	25BAMECDC03	Non Destructive Testing
4.	25BAMECDC04	Introduction to Composites
Any advanced courses can be appended in future.		

Discipline Elective – III		
S. No.	**Course Code**	**Course Title**
1.	25BAMECDC05	Gas Dynamics
2.	25BAMECDC06	Industrial Automation
3.	25BAMECDC07	Finite Element Methods
4.	25BAMECDC08	Internal Combustion Engines
Any advanced courses can be appended in future.		

Discipline Elective – IV		
S. No.	**Course Code**	**Course Title**
1.	25BAMECDC09	Computational Fluid Dynamics
2.	25BAMECDC10	Power Plant Engineering
3.	25BAMECDC11	Product Lifecycle Management
4.	25BAMECDC12	Tribology
Any advanced courses can be appended in future.		

Discipline Elective –V		
S. No.	**Course Code**	**Course Title**
1	25BAMECDC13	Total Quality Management
2	25BAMECDC14	Cryogenics and Space Propulsion
3	25BAMECDC15	Waste to Energy Conversion Technologies
4	25BAMECDC16	Digital Manufacturing
Any advanced courses can be appended in future.		

ANNEXURE – IV

List of Skill Enhancement Courses

Skill Enhancement Course – I		
S. No.	**Course Code**	**Course Title**
1.	25BAMECSC01	Data Science for Mechanical Engineers
Any Courses can be appended in future.		

Skill Enhancement Course – II		
S. No.	**Course Code**	**Course Title**
1.	25BAMECSC02	Modern Manufacturing Skills for Mechanical Engineers
Any Courses can be appended in future.		

Skill Enhancement course – III		
Sl. No.	**Course Code**	**Course Title**
1.	25BAMECSC03	Unmanned Aerial Systems and Applications
Any Courses can be appended in future.		

Skill Enhancement Course – IV		
Sl. No.	**Course Code**	**Course Title**
1.	25BAMECSC04	Generative AI for Mechanical Systems
Any Courses can be appended in future.		

I Year I Semester

B. Tech I Year I Semester

25BAENGTC01 PROFESSIONAL COMMUNICATION

L	T	P	C
2	0	0	2

Pre Requisites: Universal Human Values (UHV-I) (desirable).

Course Description :

This course aims to develop essential English communication skills required for academic, social, and professional contexts. Students will learn to convey information effectively. The program enhances reading for comprehension, promotes reading for pleasure, and trains students to write various texts including emails, reports, business letters, presentations, and posters, enabling clear and confident communication in diverse settings.

Course Objectives:

This course aims to:

1. Enable students greet, introduce themselves and others, and describe their daily routines, surroundings, and familiar places.
2. Develop the ability to narrate past events or incidents coherently and to express plans and predictions for the future.
3. Foster functional communication skills such as enquiring, requesting, giving directions, instructions, and reporting information accurately.
4. Cultivate reading proficiency by engaging with stories, enhancing comprehension, vocabulary, and critical appreciation.
5. Equip students with skills in professional writing through emails, reports, letters, posters, and visual presentations.

UNIT I EVERYDAY ENGLISH 6 hours

Basics of essential grammar; Functions of communication such as greetings, introductions, leave-taking, polite expressions; describing daily routines and habits using the simple present tense; Describing things related to family, friends, classroom, home, campus, common places, gadgets and other objects.

UNIT II NARRATION AND PLANNING 6 hours

Using past tense forms for narration; sequencing events using connectors; vocabulary related to experiences, festivals, travel, and memorable events; expressing future time; predicting events and making career plans/prospects

UNIT III FUNCTIONAL COMMUNICATION IN DAILY LIFE 6 hours

Making enquiries using wh-questions, polite questions, and indirect requests; requesting and offering help with expressions for permission, obligation, and necessity; giving directions using common roadmap vocabulary; providing and following formal/informal instructions in everyday and academic contexts; reporting information through direct and indirect speech; impersonal passive voice.

UNIT IV READING FOR COMPREHENSION AND PLEASURE 6 hours

Developing extensive reading skills through prescribed short stories: *The Victory* by Rabindranath Tagore and *The Ransom of the Red Chief* by O Henry; applying techniques of reading such as skimming, scanning, and reading for gist and detail; building vocabulary through the texts; engaging in discussions on characters, settings, and themes from the reading; practicing reading comprehension for specific details through formal email samples.

UNIT V PROFESSIONAL AND BUSINESS COMMUNICATION 6 hours

Learning principles of professional communication such as clarity, conciseness, courtesy, correctness, and formats; Email etiquette; Drafting emails/letters critically appreciating the novel/short story read in Unit 4; preparing short reports; drafting business letters such as inquiries, complaints, replies; designing posters with focus on layout, persuasive language, and visuals; delivering short presentations using visual aids.

Course Outcomes:

Students will be able to:
CO1: Greet and introduce themselves and others, describe their routines, places, and things around them.
CO2: Narrate an event or incident, planning and predicting the future
CO3: Enquire, request, give directions/instructions, report and convey information
CO4: Read for pleasure and read for comprehension
CO5: Write formal/informal emails, short reports, presentations, business letters, and make posters.

Text Books:

1. Functional English for Communication by Ujjwala Kakarla, Tanu Gupta, Leena Pundir (SAGE, 2019)
2. Communication Skills by Sanjay Kumar & Pushp Lata (Oxford University Press, 3rd Edition, 2024)
3. Extensive Reading in the Second Language Classroom" by Richard R. Day and Julian Bamford (Cambridge University Press, 2022).

Reference Books:

1. Functional English Grammar (Cambridge University Press, 2024)
2. Essentials of Business Communication by Mary Ellen Guffey & Dana Loewy (Cengage Learning, 10th Edition, 2016)
3. English for Business Communication by Mable Chan (Routledge, 2025)
4. Handbook of Communication Skills edited by Owen Hargie (Routledge)

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination

B.Tech I Year I Semester

25BAHUMTC01 HUMAN VALUES AND PROFESSIONAL ETHICS

L	T	P	C
2	0	0	2

Pre-requisite None. Universal Human Values (UHV-I) (desirable).

Course Description :

1. This course presents a universal approach to value education by developing the right understanding of reality (i.e., a worldview of the reality "as it is") through the process of self-exploration.
2. The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of reality are presented, and the students are encouraged to self-explore the proposals by verifying them based on their natural acceptance within oneself and validating experientially in living.
3. The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
4. While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students to discern the difference on their own right.
5. Thus, this course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Course Objectives :

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a right understanding of the Human reality and the rest of Existence. Such a holistic perspective forms the basis of Universal Human Values (UHV) and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4. To aid the students in realising their full human potential and act accordingly.
5. To assist the students to live with a feeling of relationship, harmony and co-existence.

UNIT I INTRODUCTION TO VALUE EDUCATION 6 hours

Lecture 1: Holistic Development and the Role of Education (Right Understanding, Relationship and Physical Facility)
Lecture 2: Understanding Value Education
Lecture 3: Self-Exploration as the Process for Value Education
Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations
Lecture 5: Happiness and Prosperity – Current Scenario

UNIT II HARMONY IN THE HUMAN BEING 6 hours

Lecture 6: Understanding Human being as the Co-existence of the self and the body
Lecture 7: The body as an Instrument of the self
Lecture 8: Understanding Harmony in the self
Lecture 9: Harmony of the self with the body
Lecture 10: Programme to ensure self-regulation and Health

UNIT III HARMONY IN THE FAMILY AND SOCIETY 6 hours

Lecture 11: Harmony in the Family – the Basic Unit of Human Interaction
Lecture 12: 'Trust' – the Foundational Value in Relationship
Lecture 13: 'Respect' – as the Right Evaluation
Lecture 14: Other Feelings, Justice in Human-to-Human Relationship
Lecture 15: Understanding Harmony in the Society

UNIT IV HARMONY IN THE NATURE/EXISTENCE 6 hours

Lecture 16: Understanding Harmony in Nature
Lecture 17: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
Lecture 18: Realizing Existence as Co-existence at All Levels
Lecture 19: The Holistic Perception of Harmony in Existence

UNIT V IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS 6 hours

Lecture 20: Natural Acceptance of Human Values
Lecture 21: Definitiveness of (Ethical) Human Conduct
Lecture 22: Competence in Professional Ethics
Lecture 23: Holistic Technologies, Production Systems and Management Models-Typical Case Studies
Lecture 24: Strategies for Transition towards Value-based Life and Profession

Course Outcomes:

After completing this Unit, students will be able to
CO1: Understand the basic human aspiration and Natural Acceptance.
CO2: Aware of themselves and self-regulation.
CO3: Recognize human-human relationship (Justice) and identify human goals in society.
CO4: Appreciate the harmony in nature and existence.
CO5: Develop as socially and ecologically responsible engineers in handling problems with sustainable solutions (user-friendly and eco-friendly).

Text Book(s)

1. R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 3rd Revised Edition, UHV Publications, Sarva Shubha Nyas, Kanpur, 2023. ISBN: 978-81-957703-7-3 (Printed Copy) ISBN: 978-81-957703-6-6 (e-book)
2. R R Gaur, R Asthana, G P Bagaria, *Teachers' Manual for a Foundation Course in Human Values and Professional Ethics,* 3rd Revised Edition, UHV Publications, Sarva Shubha Nyas, Kanpur, 2023.

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book), Annie Leonard, Free Press, 2010.
4. The Story of My Experiments with Truth, Mohandas Karamchand Gandhi, Fingerprint! Publishing
5. Small is Beautiful - E. F Schumacher, Random House, 2011.
6. Slow is Beautiful - Cecile Andrews, New Society Publishers, 2006.
7. Economy of Permanence - J C Kumarappa
8. Vivekananda - Romain Rolland

Online Resources:

1. https://fdp-si.aicte-india.org/index.php
2. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview
3. https://uhv.org.in/
4. https://www.youtube.com/@UniversalHumanValues/playlists
5. https://www.youtube.com/@mitsmadanapalle3058/playlists

Mode of Evaluation: Assignments, Mid Term Tests, End Semester Examination.

B. Tech I Year I Semester

25BAMATTC01 ENGINEERING CALCULUS

L	T	P	C
3	0	0	3

Pre Requisites: Mathematics at Intermediate or Equivalent Level

Course Description:

The course introduces the concepts of single variable and multivariable calculus with the view of its applications in various engineering fields. It prepares the students to develop various methods of finding derivatives and integrals; understanding of concepts related to continuous functions and enrich their experience in critical analysis.

Course Objectives:

1. To acquire knowledge on fundamental principles of differential calculus and polar graphing.
2. To develop proficiency in definite integrals, their applications and improper integrals.
3. To familiarize the knowledge of limit, continuity, partial derivatives, extreme values in multivariable functions.
4. To emphasize the role of double and triple integrals in dealing with area and volume of the regions.
5. To illustrate various techniques to compute line, surface and volume integrals in vector calculus.

UNIT I DIFFERENTIAL CALCULUS & POLAR GRAPHING 9 hours

Rolle's Theorem, Mean value theorems, Indeterminate forms of Limits, Taylor and Maclaurin series, Polar coordinates, Polar Graphing.

UNIT II INTEGRAL CALCULUS 9 hours

Definite integrals, Applications of definite integrals to evaluate area and lengths of curves (polar and parametric), volume and surface area of revolutions (polar and parametric), Beta and Gamma functions

UNIT III MULTIVARIABLE DIFFERENTIAL CALCULUS 9 hours

Functions of severable variables, Limits, Continuity, Partial derivatives, Chain rule, Directional derivative and gradient vectors, Extreme values and Saddle points, Constrained maxima and minima, Lagrange multipliers.

UNIT IV MULTIVARIABLE INTEGRAL CALCULUS 9 hours

Multiple Integrals: Double integrals (Cartesian and polar), Reversing the order of integration (Cartesian), Change of integrals (Cartesian to polar), triple integrals, cylindrical and spherical coordinates, Jacobian, Substitutions in Multiple Integrals.

UNIT V MULTIVARIABLE VECTOR CALCULUS 9 hours

Line Integrals-work, circulation, flux; curl and divergence, Green's theorem (without proof), surface Integral, Stokes' and Divergence theorems (without proofs).

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Apply the mean value theorems, series expansions and tracing the polar curves in engineering.

CO2: Utilize the definite integrals, Beta and Gamma functions to determine length and underlying area of curves.

CO3: Evaluate the rates of change in time and space variables through the analysis of multivariable functions in engineering.
CO4: Compute multiple integrals in various coordinate systems for engineering applications.
CO5: Employ vector calculus operators and theorems to analyze integrals over curves, surfaces, and volumes**.**

Text Books:

1. George B. Thomas, Maurice D. Weir, Joel R. Hass, Thomas' Calculus, Pearson Education 12th Edition, 2014.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42th Edition, 2012.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2006.
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. R.K. Jain, S.R.K. Iyengar, Advanced Engineering Mathematics, Alpha Science International Ltd. 4th Edition, 2014.
4. Michael D. Greenberg, Advanced Engineering Mathematics, Prentice Hall, 2nd Edition, 1998.
5. Stanley J. Miklavcic, An Illustrative Guide to Multivariable and Vector Calculus, Springer, 2019.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year I Semester

25BAPHYTC01 ENGINEERING PHYSICS

L	T	P	C
3	0	0	3

Pre Requisites: Plus two level physics courses

Course Description:

This course provides foundational physics concepts for students in electrical, mechanical, and civil engineering. It covers oscillations and waves, wave optics, quantum mechanics, semiconductors, lasers, and the dielectric and magnetic properties of materials, with an emphasis on applications in modern science and technology.

Course Objectives:

1. Understand oscillations, wave equations, and their applications in engineering systems.
2. Apply principles of interference, diffraction, and polarization in material testing and optical devices.
3. Explain fundamental quantum mechanics concepts and free electron theory for materials.
4. Analyze semiconductor physics and laser operation for scientific and industrial applications.
5. Understand the dielectric and magnetic properties of materials for modern technological use.

UNIT I WAVES AND OSCILLATIONS 9 hours

Simple harmonic motion, damped harmonic oscillations, forced harmonic oscillations, resonance, and quality factor. Transverse waves, one-dimensional wave equation, solution for wave equation, velocity of a transverse wave along a stretched string, modes of vibration of stretched string, standing waves, standing wave ratio, applications (shock absorbers, seismograph, and musical instruments: discussion only).

UNIT II OPTICS 9 hours

Superposition of waves, Young's double slit experiment, Newton's rings experiment. Diffraction, Farunhofer diffraction due to a single slit, double slit and Diffraction grating (N-slit) (Qualitative). Polarization, Types of Polarization, Polarization by reflection, refraction and double refraction, Nicol's prism, Half-wave and Quarter-Waveplates.

UNIT III QUANTUM MECHANICS & FREE ELECTRON THEORY 9 hours

de-Broglie's hypothesis, Uncertainty principle (Qualitative only), Postulates of quantum mechanics, Schrodinger wave equations, particle in a box.

Free electron theory (drift velocity and electrical conductivity), Fermi energy level, density of states, Origin of energy bands, Classification of solids.

UNIT IV SEMICONDUCTORS and LASERS 9 hours

Semiconductors: direct & indirect band gap, intrinsic and extrinsic types, carrier density and Fermi level variation, p-n junction diode, drift & diffusion currents, Hall effect.

Lasers: spontaneous & stimulated emission, Einstein coefficients, Resonator, Ruby and semiconductor lasers.

UNIT V DIELECTRIC AND MAGNETIC MATERIALS 9 hours

Dielectric polarization, Susceptibility, Dielectric constant and Displacement Vector, Relation between the electric vectors, Electronic, Ionic and Orientation polarizations (Qualitative), Lorentz internal field, Clausius-Mossotti equation.

Magnetic dipole moment, Magnetic susceptibility and permeability, atomic origin of magnetism, Classification of magnetic materials, Domain theory, ferromagnetic hysteresis.

Course Outcomes:

At the end of this course, students will be able to:

CO1: Apply wave equations and principles of oscillation to analyze mechanical and electrical systems.

CO2: Use interference, diffraction, and polarization for testing and optical applications.

CO3: Solve simple quantum mechanical problems and explain free electron behavior in solids.

CO4: Analyze semiconductor properties and laser operation for practical applications.

CO5: Explain the dielectric and magnetic properties of materials and their technological relevance.

Text Books:

1. Engineering Physics – Dr. M.N. Avadhanulu & Dr. P.G. Kshirsagar, S. Chand and Company, 2014.
2. Engineering Physics – K. Thyagarajan, McGraw-Hill Publishers, 2015.
3. Concepts of Modern Physics by Arthur Beiser, 7th Edition, 2017.

Reference Books:

1. H. J. Pain, The physics of vibrations and waves, Wiley, 2006.
2. Physics Vol I & II, Halliday/Resnick/Krane 5th Edition, John Wiley, 2003.
3. B.G. Streetman, “Solid State Electronic Devices”, Prentice Hall of India, 1995.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year I Semester

25BACAITC02 FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

L	T	P	C
2	0	0	2

Pre-Requisites: NIL

Course Description:

This course introduces the fundamentals of Artificial Intelligence (AI) with applications in Civil, Mechanical, and Electrical engineering. Topics include intelligent systems, simple decision-making methods, learning from data, and practical problem-solving examples. Students will also explore the ethical, safety, and societal impacts of AI. The course equips learners with a foundational understanding of AI concepts and its potential role in future engineering practice.

Course Objectives:

1. Provide a basic understanding of Artificial Intelligence concepts.
2. Introduce the idea of machines learning from data.
3. Explain simple decision-making and problem-solving methods.
4. Familiarize students with AI applications in Civil, Mechanical, and Electrical engineering.
5. Create awareness about the ethical and societal impacts of AI.

UNIT I INTRODUCTION TO AI **6 hours**

What is AI? – Examples in daily life – Role of AI in engineering – AI in construction, manufacturing, and power systems – Benefits and limitations.

UNIT II BASICS OF LEARNING FROM DATA **6 hours**

Idea of learning – Examples of AI learning from past experience – Basic introduction to classification and prediction (concept only) – Applications in weather prediction, equipment maintenance, and energy usage forecasting.

UNIT III KNOWLEDGE AND DECISION MAKING **6 hours**

Storing and using information – Simple rules for decision-making – Examples: Traffic signal control, fault detection in machines, monitoring building safety.

UNIT IV INTELLIGENT SYSTEMS **6 hours**

Understanding intelligent machines – Examples of intelligent agents (robots, sensors, smart devices) – How AI systems interact with the environment – Simple real-life problem-solving examples.

UNIT V AI IN PRACTICE AND FUTURE TRENDS **6 hours**

Familiarity with simple AI tools (basic overview only) – AI applications in Civil, Mechanical, and Electrical domains – Safety, ethics, and social impact – Future opportunities in engineering with AI.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Explain the basic concepts and scope of Artificial Intelligence.
CO2: Recognize basic machine learning ideas and their uses in engineering
CO3: Describe simple problem-solving approaches used by intelligent systems.
CO4: Identify AI applications relevant to their engineering field.
CO5: Discuss ethical, safety, and societal considerations in AI use.

Text Books:

1. Wolfgang Ertel, Introduction to Artificial Intelligence, Springer, 2021.

2. Stuart Russell and Peter Norvig, Artificial Intelligence – A Modern Approach, Pearson, 2021 (selected simplified readings).

Reference Books:

1. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, *Artificial Intelligence*, McGraw Hill, 2019.

2. Tom M. Mitchell, *Machine Learning*, McGraw Hill, 2017 (conceptual sections only).

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year I Semester

25BAMECTC01 MATERIALS SCIENCE FOR ENGINEERS

L	T	P	C
3	0	0	3

Pre-requisite: None

Course Description:

This course provides a comprehensive introduction to materials science, covering the classification, structure, properties, and applications of metals, alloys, ceramics, polymers, composites, and advanced materials. Students will learn about material selection, mechanical behavior, phase diagrams, and manufacturing processes, including powder metallurgy, ceramic processing, and polymerization. The course also explores smart and advanced materials such as shape memory alloys, piezoelectric materials, nanomaterials, and biomaterials, emphasizing their role in modern engineering applications.

Course Objectives:

This course is designed to:

1. Understand the fundamental classification and properties of engineering materials.
2. Explore the structure, properties, and applications of metals and alloys.
3. Gain knowledge on composite materials and their relevance in engineering fields.
4. Learn about the structure and characteristics of ceramics and polymers.
5. Develop an appreciation of smart and advanced materials for modern technologies.

UNIT I CLASSIFICATION OF MATERIALS 9 hours

Introduction to materials science, Classification: Metals, Ceramics, Polymers, Composites, Semiconductors, Biomaterials, Properties, Materials selection for different applications.

UNIT II METALS AND ALLOYS 9 hours

Types of metals: Ferrous and non-ferrous, Microstructure of metals, Phase diagrams (binary alloys), Heat treatment of steels, Mechanical behavior and testing: Stress-strain, hardness, fatigue, Common engineering alloys and their applications.

UNIT III COMPOSITES 9 hours

Definition and classification: Particle-reinforced, fiber-reinforced, structural composites, Matrix materials: Polymer, metal, and ceramic matrix, Manufacturing techniques: Hand lay-up, pultrusion, Introduction to Powder Metallurgy, Applications.

UNIT IV CERAMICS AND POLYMERS 9 hours

Structure and types of ceramics: Crystalline and amorphous, Properties, Processing of ceramics: Sintering, slip casting, hot pressing, Types of polymers: Thermoplastics, thermosets, elastomers, Polymerization processes, Applications.

UNIT V SMART AND ADVANCED MATERIALS 9 hours

Need for smart materials and advanced materials, Shape memory alloys, piezoelectric materials, magnetostrictive materials, Electroactive polymers, self-healing materials, photonic crystals, Nanomaterials and carbon-based materials (graphene, CNTs), Biomaterials.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Identify and classify materials based on their properties and structure.
CO2: Understand the behaviour and applications of metals and alloys in engineering.
CO3: Compare the types and uses of composites in various mechanical applications.
CO4: Understand the processing and properties of ceramics and polymers.
CO5: Identify the emerging applications of smart and advanced materials

Text Books:

1. Callister, W. D., & Rethwisch, D. G. (2020). Materials science and engineering: An introduction (10th ed.). Wiley.
2. Smith, W. F., Hashemi, J., & Prakash, R. (2021). Materials science and engineering (6th ed., SI units). McGraw Hill Education.
3. Upadhyaya, G. S., & Upadhyaya, A. (2022). Materials science and engineering (Revised ed.). Viva Books.

Reference Books:

1. Raghavan, V. (2018). Materials science and engineering (6th ed.). Prentice Hall of India.
2. C. Barry Carter and M. Grant Norton, Ceramic Materials: Science and Engineering, Springer, 3rd Edition, 2023.
3. Bhattacharya, D. (2023). Smart materials and structures (2nd ed.). Oxford University Press.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year I Semester

25BAENGLC01 PROFESSIONAL COMMUNICATION LABORATORY

L	T	P	C
0	0	2	1

Course Description:

This course enhances proficiency in English communication with emphasis on fluency, accurate pronunciation, and confidence. It develops speaking, listening, reading, and writing skills through structured activities. Learners will also develop competence in composing formal correspondence, reports, presentations and designing effective posters.

Course Objectives:

This course aims to:

1. Enable students to confidently greet others, introduce themselves and others in professional and cross-cultural contexts, and describe their everyday routines, roles, environments, and familiar locations with clarity.
2. Build the skill to narrate past experiences, achievements or memorable events clearly and to articulate professional goals, plans and predictions for the future.
3. Enhance practical communication skills such as making enquiries, requesting, giving directions or offering clarifications, and drafting accurate reports in academic and workplace settings.
4. Strengthening reading and listening skills by engaging with stories to improve comprehension, vocabulary, and critical appreciation.
5. Prepare students to compose formal emails, reports, letters, and to make posters, and deliver presentations using effective English expressions, structures, and style.

Lab Activities

Activities shall include listening tasks and a revisit of grammar, vocabulary, pronunciation, and intonation (wherever required)

1. Introduction to sounds of English, stress and intonation for apt pronunciation
2. Greetings; Introducing oneself and others; conversations
3. Describing a person, place, object, etc.
4. Narrating a personal incident/events
5. Planning/predicting a future event/prospects
6. Skit on enquiring and requesting
7. Roleplays on giving formal/informal instructions and reporting what has been done so far in the lab / general scenario
8. Listening to select video/audio and discussing a favorite part of the story/ documentary in groups.
9. Reading comprehension and reading business emails
10. Writing email, letters/reports
11. Presentations and making posters (online and offline)

Course Outcomes:

Students will be able to:

CO1: Speak English fluently with a good pronunciation in an Indian accent, and confidently handle greetings, introductions, and provide descriptions of their routines, locations, and surrounding objects.

CO2: Narrate stories, incidents, or personal experiences, as well as engage in planning and predicting future possibilities using appropriate English structures.

CO3: Demonstrate effective English communication by asking questions, making polite requests, giving instructions, and presenting reports or information clearly.

CO4: Apply listening and reading skills for comprehension, interpretation, and language development in both academic and professional contexts.

CO5: Compose grammatically correct and well-structured formal emails, reports, presentations, and business letters, and design posters with clear English expressions.

Text Books:

1. Communicative English – A Workbook by Shobha K.N. & Rayen J. Lourdes (Cambridge University Press, 2019)

Reference Books:

1. Communication Skills: A Workbook by Sanjay Kumar & Pushp Lata (Oxford University Press, 2019)
2. ELCS Lab Manual: A Workbook for CALL and ICS Lab Activities (Board of Editors, Orient Black Swan Pvt. Ltd., 2016)
3. English Language Skills: A Practical Approach by Veerendra Mishra et al. (Cambridge University Press, 2020)

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination

B. Tech I Year I Semester

25BAPHYLC01 PHYSICS LABORATORY

L	T	P	C
0	0	2	1

Pre-requisites: Plus two physics knowledge

Course Description:

This course offers a comprehensive exploration of fundamental physics principles through a series of well-designed experiments, emphasizing both conceptual understanding and hands-on measurement techniques.

Course Objectives:

1. To experimentally analyze and quantify optical phenomena such as interference, diffraction, and polarization, using techniques like Newton's rings, single slit, and diffraction grating.
2. To determine and understand essential material and electronic properties, including energy gap in semiconductors and the mechanical strength of materials using specialized methods.
3. To measure and interpret magnetic and electromagnetic characteristics by studying B-H curves, magnetic fields, and resonance phenomena in electrical circuits.
4. To estimate fundamental physical constants such as Planck's constant and the charge-to-mass ratio of an electron using classical experimental setups.
5. To develop skills in conducting precise experimental investigations, analyzing data, and deriving key physical quantities relevant to modern physics and engineering applications.

List of Experiments:

1. Determination of radius of curvature of a given Plano-convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. To determine the slit width (d) using the diffraction pattern produced by a single slit.
4. To determine the Brewster's angle and refractive index of a glass.
5. Determination of Frequency of electrically maintained tuning fork by Melde's experiment.
6. Study the variation of B versus H by magnetizing the magnetic material (B-H curve).
7. Determination of wavelength of Laser light using diffraction grating.
8. Determination of energy gap of a semiconductor using p-n junction diode.
9. Magnetic field along the axis of a current carrying circular coil by Stewart Gee's Method.
10. Determination of young's modulus for the given material of wooden scale by non-uniform bending (or double cantilever) method.
11. Estimation of Planck's constant using photoelectric effect.
12. Determination of numerical aperture and acceptance angle of an optical fiber.
13. To study the frequency response of series LCR circuit-resonance frequency, band width and quality factor.
14. To find the charge to mass ratio of an electron using Thomson's method.

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO experiments may be conducted in virtual mode.

Instruments Requirements:

Light sources (Mercury vapor lamp, sodium vapor lamp, Lasers), single slits with mount, diffraction gratings, translation stages with microscopes, spectrometer, P-N junction diode kit, vibration tuning fork, B-H curve apparatus, Meld's apparatus, optical fibers and lens, screen assembly, circular magnetic coil and stewartias and gee arrangement, e/m measurement kit, Planks constant measurement apparatus, Regulated Power supplies, Rheostats, Ammeters, Voltmeter, Active & Passive Electronic Components, LCR kit. Wooden scale, glass slab.

Course Outcomes:

CO1: Know the various phenomena of light practically and gain knowledge about various optical technique methods.

CO2: Verify the theoretical concepts of optics, magnetism, waves and oscillations by hands on experiment.

CO3: Apply the scientific process in the conducting of experiments and report the experimental findings.

CO4: Understand mechanical phenomena by instruments and apply them in real time applications.

CO5: Acquire and interpret experimental data to examine the physical laws.

Reference Books:

1. A Textbook of Practical Physics - S. Balasubramanian, M.N. Srinivasan, S. Chand Publishers, 2017.
2. Engineering Physics Laboratory Manual, Jayaraman, 2013, Pearson Education.
3. A Course of Experiments with He-Ne Lasers, R.S. Sirohi, New Age International (P) limited, Publishers, 1985.

Web Resources: www.vlab.co.in
https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination

B. Tech I Year I Semester

25BACSELC04 PROBLEM SOLVING USING PYTHON LABORATORY

L	T	P	C
0	0	4	2

Pre Requisites:

Course Description:

This course introduces fundamental concepts of problem-solving using Python, with a specific focus on its application in engineering. It equips students with the skills to use Python's core libraries like NumPy, Pandas, and Matplotlib, to analyze, visualize, and interpret engineering datasets. The curriculum emphasizes computational thinking and hands-on laboratory exercises to process data, identify trends, and develop automated solutions for engineering problems.

Course Objectives:

1. Understand essential concepts of Python programming and its role in engineering
2. Demonstrate proficiency in numerical operations and data analysis using NumPy and Pandas.
3. Apply Python to process, visualize, and interpret engineering datasets.
4. Develop skills in reading, writing, and visualizing tabular data for civil and mechanical engineering contexts
5. Foster computational thinking and logical problem-solving through hands-on labs

List of Experiments:

Experiment 1: Python Fundamentals and Lab Setup: Basics of Python, installation, IDE setup, variables, types, Input/output, arithmetic operations.

Experiment 2: Working with Strings: String creation, indexing, slicing, methods, formatting.

Experiment 3: Control Flow and Conditional Logic: Conditionals, Boolean logic, if/elif/else, comparisons

Experiment 4: Iterative Operations with Loops: For, while, range( )

Experiment 5: Functions for Modular Programming: Defining, calling, parameters, returns

Experiment 6: Storing Data with Lists: Creation, indexing, slicing, methods. Storing measurement data.

Experiment 7: Dictionaries for Data Organization: Key-value pairs, operations.

Experiment 8: Tuples & Sets + Review: Tuples (immutable), sets (unique).

Experiment 9: File Handling: Read/write text, CSV files.

Experiment 10: Error Handling: try/except for robust input and processing.

Experiment 11: Introduction to NumPy: Arrays, indexing, vectorized operations.

Experiment 12: Pandas for Data Analysis: Creating Data Frames, indexing, selection.

Experiment 13: Data Cleaning and Manipulation with Pandas: Handling NaN values, filtering, sorting.

Experiment 14: Data Aggregation with Pandas: groupby, aggregation, statistics

Experiment 15: Matplotlib for Visualization: Customization (colors, markers) & Subplots

Experiment 16: Advanced Visualization with Matplotlib: Advanced visualization technique (Histograms, Scatter, Pie Charts)

Experiment 17: Integrated Data Analysis & Visualization: Combine Pandas & Matplotlib for engineering reports

Course Outcomes:

CO1: Recall basic Python syntax, fundamental data types, and common libraries (NumPy, Pandas).
CO2: Demonstrate control flow, functions, and basic file/data operations for solving engineering problems.
CO3: Apply NumPy arrays and Pandas DataFrames for numerical computations and engineering data analysis.
CO4: Analyze engineering data to identify trends and summarize results using visualization.
CO5: Evaluate and compare different approaches (e.g., arrays vs. lists, manual vs. automated analysis) for typical engineering tasks.

Text Books:

1. Python for Everybody: Exploring Data in Python 3 by Charles Severance, 2016.
2. Automate the Boring Stuff with Python: Practical Programming for Total Beginners by Al Sweigart, 3rd Edition 2025.
3. Think Python: How to Think Like a Computer Scientist by Allen B. Downey, 2nd Edition 2016.
4. Python for Science and Engineering (Online PDF)

References:

1. Official Python Documentation – docs.python.org
2. NumPy Documentation – numpy.org
3. Pandas Documentation – pandas.pydata.org
4. Matplotlib Documentation – matplotlib.org

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination

B. Tech I Year I Semester

25BACOMLC01 ENGINEERING SKILLS LABORATORY

L	T	P	C
0	0	2	1

Pre-Requisites Nil

Course Description:

This course provides hands-on experience in using basic electrical/electronic instruments and circuit design. and to develop practical skills in microcontroller programming and device interfacing for real-time applications. And provides hands-on training in fundamental manufacturing and fabrication processes used in mechanical engineering. Students will develop practical skills through activities such as sheet metal product development, plastic fabrication, 3D printing, woodwork using carpentry tools, laser engraving, and metal welding. The course also introduces the operation and applications of various mechanical power tools, CNC lathe, and milling machines, enabling learners to gain exposure to modern and traditional manufacturing techniques.

Course Objectives:

By the end of this course, the student will be able to:

1. To provide hands-on experience in using basic electrical/electronic instruments and circuit design.
2. To develop practical skills in microcontroller programming and device interfacing for real-time applications.
3. Provide hands-on experience in basic fabrication processes using sheet metal, plastics, wood, and welding to develop simple utility products.
4. Familiarize students with modern manufacturing technologies such as 3D printing, CNC machining, and laser engraving for product realization.
5. Enable students to understand, identify, and safely operate various mechanical engineering tools and equipment for engineering applications.

PART – A

Study Experiments:

1. Familiarization with Instrumentation and Tools
2. Understanding the microcontroller architecture and Programming

Choose any six from the following list of experiments:

1. Clock Pulse Generation and Signal Analysis using Digital Storage Oscilloscope (DSO).
2. Measurement of Electrical Power, Power Factor, and Energy using Portable Meters.
3. Study, Design and Testing of Full-Wave Bridge Rectifier Circuit.
4. Study, Design and Implementation of a SMPS.
5. Study, Design and Testing of Multiplexer using Logic Gates.
6. Interfacing of 7-Segment Display, Buzzer, Sensor with microcontroller.
7. Speed and Angle Control of Servo Motor using Microcontroller.
8. PCB Soldering Techniques and Testing Using a Multimeter.

Content Beyond the Syllabus (Virtual Laboratory)

9. Familiarisation of ICs.
10. Application of basic logic gates in fire and burglar alarms.
11. Wiring of a simple circuit for controlling

    (1) a lamp/fan point,
    (2) a staircase or corridor winding,
    (3) an electrical appliance (16A socket).

PART – B

List of Experiments:

1. Utility product development using sheet metal.
2. Plastic product fabrication.
3. 3D printing of simple components.
4. Wood product fabrication using carpentry tools.
5. LASER engraving.
6. Metal welding and fabrication.
7. Study of different mechanical engineering power tools.
8. Study of CNC Lathe and Milling machining processes.

Content beyond Syllabus

9. Plumbing
10. Computer Controlled Cutting of wooden object
11. 3D Machining

Course Outcomes: At the end of the course, the student will be able to

CO1: Demonstrate soldering, measurement, and testing techniques using basic electrical/electronic instruments.

CO2: Design and implement simple circuits and microcontroller-based applications for power and control systems

CO3: Demonstrate the ability to fabricate simple components using sheet metal, wood, and welding processes.

CO4: Analyze and compare traditional and modern manufacturing techniques such as 3D printing, CNC machining, and laser engraving.

CO5: Select and operate appropriate hand tools, power tools, and machine tools for given product development tasks with safety considerations.

Text Books:

1. R. S. Sedha, A Textbook of Applied Electronics, S. Chand & Company Ltd.
2. Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson Education.

3. V. Ramesh Babu, Engineering Workshop practice for JNTU, VRB Publishers Pvt. Ltd. 2023.
4. A. K. Sarathe, Engineering Workshop Practice, 1st edition, Khanna Book Publishers, 2022
5. Lab manual provided by the departments.

Reference Books:

1. Boylestad & Nashelsky, Electronic Devices and Circuit Theory, Pearson Education.
2. David A. Bell, Electronic Instrumentation and Measurements, Oxford University Press.
3. The Art of Electronics by Paul Horowitz and Winfield Hill, Cambridge University Press.
4. Sanjay Gupta & Santosh Gupta, SMPS: Switch Mode Power Supply, Technical Publications.
5. Boylestad & Nashelsky, Electronic Devices and Circuit Theory, Pearson Education.
6. P.Kannaiah, K.L.Narayana, Workshop Manual, 2nd Edition, SciTech Publishers, 2009.
7. K.C. John, Mechanical Workshop Practice, 2nd edition, Kindle Edition, 2010.
8. https://fab-coep.vlabs.ac.in/

Mode of Evaluation: Continuous Internal Evaluation, Model Test and End Semester Examination.

I Year II Semester

B. Tech I Year II Semester

25BAMATTC03 LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS

L	T	P	C
3	0	0	3

Pre Requisites: 25BAMATTC01

Course Description:

This course provides an introduction to Linear Algebra and Differential Equations with applications in science and engineering. Topics include matrices, systems of equations, eigenvalues and eigenvectors, methods for solving first and second order differential equations, Laplace transforms, and partial differential equations with applications to wave and heat equations.

Course Objectives:

1. To solve the system of linear equations, eigenvalues and eigenvectors.
2. To formulate and solve first order ordinary differential equations.
3. To solve second order differential equations of various kinds.
4. To introduce Laplace Transforms methods for solving ordinary differential equations.
5. To obtain the solutions of partial differential equations representing initial and boundary value problems in engineering.

UNIT I LINEAR ALGEBRA 9 hours

Introduction to matrices -Rank and inverse of a matrix - system of linear equations, Eigenvalues and Eigenvectors, diagonalization of matrices, Cayley-Hamilton theorem (without proof).

UNIT II FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS 9 hours

Introduction - General Remarks on Solutions, Families of Curves, Orthogonal Trajectories, Homogeneous Equations, Exact Equation, Integrating Factors, Linear differential equations and Bernoulli's equation.

UNIT III SECOND ORDER ORDINARY DIFFERENTIAL EQUATIONS 9 hours

Introduction of second order linear differential equations - General solution of the homogeneous equation, Homogeneous equation with constant coefficients, Euler's equi-dimensional equation, Wronskian, Method of variation of parameters, Operator methods for finding particular solutions.

UNIT IV LAPLACE TRANSFORMS 9 hours

Laplace Transform, Inverse Laplace transform, Convolution theorem, applications to solve Integral equations and ordinary differential equations.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS 9 hours

Definition and formulation of partial differential equations, Eigenvalues and Eigenfunctions, method of separation of variables, one dimensional wave equation; One dimensional heat flow, solution of the heat equation.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Solve the system of linear equations and obtain the Eigenvalues and Eigenvectors.

CO2: Solve the first order ordinary differential equations.

CO3: Apply the knowledge of identifying, formulating and solving engineering problems represented by second order differential equations.

CO4: Analyze the Laplace Transforms and apply Laplace Transforms to solve ordinary differential equations in engineering.

CO5: Represent the relevant engineering system into pertinent partial differential equation, solve it and interpret the results.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.
2. Simmons G.F., Differential Equations with Applications and Historical Notes, Tata McGraw Hill Edition 2003, Eighteenth reprint 2010.

Reference Books:

1. George B. Thomas, Maurice D. Weir, Joel R. Hass, Thomas' Calculus, Pearson Education 12th Edition, 2014.
2. Linear Algebra with Applications, Gareth Williams, Jones & Bartlett Learning, 9th Edition, 2018.
3. Jin Ho Kwak and Sungpyo Hong, Linear Algebra, Birkhaüser, Second edition, 2004.
4. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2006.
5. William E. Boyce., Richard C. Diprima., Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons, Inc., 7th Edition, 2001.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year II Semester

25BACHETC01 ENGINEERING CHEMISTRY

L	T	P	C
3	0	0	3

Pre Requisites: Intermediate Level

Course Description:

This course introduces essential concepts of chemistry relevant to civil and mechanical engineering, including water treatment, electrochemistry, corrosion, polymers, fuels, modern engineering materials, and nanomaterials. Students will learn the principles, properties, and applications of these materials and processes in engineering practice, emphasizing practical solutions for industrial and environmental challenges.

Course Objectives:

1. To familiarize engineering chemistry and its applications
2. To impart the concept of soft and hard waters, softening methods of hard water
3. To train the students on the principles and applications of electrochemistry, polymers, nanomaterials, and cement

UNIT I WATER TECHNOLOGY **9 hours**

Specifications for drinking water as per BIS and WHO standards

Impurities present in water:- Types of hardness, units of hardness, disadvantages of hardness of water, Estimation of hardness of water by EDTA Method, Alkalinity, Estimation of dissolved Oxygen

Boiler troubles –Priming, foaming, scale and sludge, Caustic embrittlement,

Industrial water treatment:– Ion-exchange processes, desalination of brackish water by reverse osmosis (RO), electrodialysis.

UNIT II ELECTROCHEMISTRY AND CORROSION **9 hours**

Electrodes –electrochemical cell, Nernst equation, cell potential calculations.

Super capacitors – Classifications & applications

Batteries- classification, Primary cells – Zinc-air battery, Secondary cells – lithium-ion batteries-working principles including cell reactions; Fuel Cells-Basic Concepts, the principle and working of hydrogen-oxygen Fuel cell.

Corrosion: Introduction to corrosion, differential aeration cell corrosion, galvanic corrosion, Factors affecting the corrosion, cathodic and anodic protection, electroplating (Nickel and Copper) and electroless deposition. Surface Coating on thin films.

UNIT III POLYMERS AND FUEL CHEMISTRY **9 hours**

Introduction to polymers, types of polymerizations, Thermoplastics and Thermo-setting plastics-: Preparation, properties and applications of Teflon, PVC, Nylon 6,6 and Bakelite. Elastomers – Preparation, properties and applications of Buna S, Buna N.

Biodegradable polymers – PLA & PGA

Fuels: Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetane number-alternative fuels- biodiesel.

UNIT IV MODERN ENGINEERING MATERIALS **9 hours**

Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications

Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils– Viscosity,

Viscosity Index, Flash point, Fire point, Cloud point, saponification number.
Building materials- Portland Cement, constituents, Setting and Hardening of cement (with chemical reactions).

UNIT V NANOMATERIALS AND SUPERCONDUCTORS 9 hours

Nanomaterials: Introduction, classification (Material based), properties (Electrical, catalytic, magnetic, mechanical, super conducting, optical) and applications of Nano materials (nano particles, nano tubes, nano wires, nano composites, dendrimers); synthesis of Nanomaterials – Sol-gel process and precipitation method.
Super Conductors: Introduction, basic concept (BCS Theory), Classification Properties and applications.

Course Outcomes:

At the end of the course, the students will be able to:

CO1: Explain the estimation of impurities present in water like hardness, alkalinity and softening of impure water.
CO2: Explain the working principles of batteries & demonstrate the corrosion prevention methods and factors affecting corrosion
CO3: Explain the preparation, properties, and applications of thermoplastics, thermosetting, elastomers, conducting polymers & explain calorific values, octane number, refining of petroleum and cracking of oils.
CO4: Explain the setting and hardening of cement, properties of composites and lubricants.
CO5: Summarize the properties & applications of super conductors and nanomaterials.

Text Books:

1. Jain and Jain, Engineering Chemistry, 16/e, DhanpatRai, 2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e,Oxford University Press, 2010.
3. G V Subba Reddy, K N Jayaveera, C Ramachandraiah, Engineering Chemistry, McGraw-Hill;First Edition, 2019.

Reference Books:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J. Shaw, Introduction to Colloids and Surface Chemistry, Butterworth-Heineman, 1992.
3. Textbook of Polymer Science, Fred W. Billmayer Jr, 3rd Edition

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B.Tech I Year II Semester

25BACIVTC02 INTRODUCTION TO ENVIRONMENT AND SUSTAINABILITY

		L	T	P	C
Pre-Requisites:	None	**2**	**0**	**0**	**2**

Course Description:

This course provides foundational knowledge of environmental systems, biodiversity, and sustainability. It addresses major environmental challenges like pollution and climate change, and introduces students to key policies, global sustainability frameworks, and sustainable engineering practices.

Course Objectives:

1. Understand the interdependence between environmental system and human well-being.
2. Analyze key environmental issues including pollution, climate change, and resource degradation.
3. Interpret environmental laws, standards, and global sustainability agreements.
4. Evaluate sustainability frameworks and the role of engineering in achieving development goals.
5. Apply sustainable engineering principles to address real-world environmental challenges.

UNIT I ENVIRONMENTAL SYSTEMS 6 hours

Definition, scope, and importance of environment - Components of ecosystem: biotic and abiotic - Energy flow in ecosystems (food chains, food webs) - Biogeochemical cycles: Water, Carbon, Nitrogen - Biodiversity: definition, values, and threats - Overview of natural resources: renewable vs. non-renewable

UNIT II ENVIRONMENTAL CHALLENGES 6 hours

Pollution: definition, types (Air, Water, Soil, Noise) - Causes, effects, and basic control measures - Urbanization – Land degradation - Solid and E-waste management –- Climate change, global warming, greenhouse effect - Ozone depletion and carbon footprint

UNIT III ENVIRONMENTAL POLICIES 6 hours

Overview of ISO 14001:2015 - Roles of CPCB, SPCBs, and NGT - Key environmental acts (Air, Water, Forest, Wildlife) - International agreements: Montreal, Kyoto, Paris Agreement - Basics of Environmental Impact Assessment (EIA) - Introduction to carbon credit and energy auditing

UNIT IV SUSTAINABILITY GOALS 6 hours

Foundations of Sustainability- Definition, Concept, needs and challenges- principles of sustainability - Evolution of Global Sustainability Frameworks - Agenda 21, millennium development goals, and protocols - Sustainable Development Goals - targets, indicators – Role of engineering and technology in achieving SDGs

UNIT V SUSTAINABLE ENGINEERING APPROACHES 6 hours

Introduction to Sustainability in Engineering - Guiding principles and Frameworks for sustainable engineering – Sustainability approaches - Triple bottom Line, Cradle to Cradle concept - Life cycle assessment - Zero waste and R concept - Circular economy - ISO 14000 Series

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Recommend ecofriendly solution to protect ecosystem.
CO2: Identify appropriate pollution control methods for specific situations.
CO3: Demonstrate the use of renewable energy for sustainable development.
CO4: Apply techniques to reduce environmental impact from climate change.
CO5: Utilize environmental laws and policies to promote sustainable practices.

Text Books:

1. R. L. Rag and Lekshmi Dinachandran Remesh. Introduction to Sustainable Engineering. 2nd Edition,PHI Learning Pvt. Ltd., 2016.
2. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Scienceand Conservation. S. Chand Publishing, New Delhi.
3. **Masters, Gilbert M. & Ela, Wendell P.** – *Introduction to Environmental Engineering and Science*, Pearson Education, 3rd Edition, 2013
4. Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development,Cengage learning
5. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies,Prentice Hall
6. Richard T. Wright, Dorothy F. Boorse (2017) Environmental Science: Toward A Sustainable Future,Pearson, 13th Edition

Reference Books:

1. R.C. Sohal & S.K. Agrawal – *Environmental Studies*, University Science Press, 2018.
2. Erach Bharucha – *Textbook of Environmental Studies for Undergraduate Courses*, University Grants Commission, 2nd Edition, 2013.
3. Peavy, H.S., Rowe, D.R. & Tchobanoglous, G. – *Environmental Engineering*, McGraw Hill Education, 2017.
4. R.K. Trivedi & P.K. Goel – *An Introduction to Air Pollution*, B.S. Publications, 2015.
5. Harris, Frances (2012) Global Environmental Issues, 2nd Edition. Wiley-Blackwel
6. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
7. Leelakrishnan, P. (2022). *Environmental law in India* (Vol. 1). LexisNexis.
8. Ghosh, S. (Ed.). (2019). *Indian environmental law: Key concepts and principles*. Orient BlackSwan.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B.Tech I Year II Semester

25BAEEETC02 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

		L	T	P	C
Pre Requisites:	None	**3**	**0**	**0**	**3**

Course Description:

This course introduces the fundamentals of DC and AC circuits, electrical measurements, and sensors. This course covers the construction, principles, and applications of electrical machines along with essential safety practices. Students can learn about semiconductor devices, their applications in circuits, and basics of digital electronics. The course builds a strong foundation in electrical and electronic engineering concepts for beginners.

Course Objectives:

1. Introduce the basics of DC and AC circuits and power systems.
2. Explain the principles of electrical measurements and sensors.
3. Describe the construction and operation of common electrical machines.
4. Familiarize students with semiconductor devices and their applications.
5. Cover fundamentals of digital electronics and logic circuit design.

UNIT I INTRODUCTION TO DC AND AC CIRCUITS 9 hours

DC Circuits: Basic circuit elements and sources; Ohm's law; Kirchhoff's laws; Series and Parallel connection of circuit elements; Mesh current analysis; Node voltage analysis.
AC Circuits: Alternating voltages and currents, RMS, average, maximum values, Single Phase RL, RC, RLC series circuits, Power in AC circuits, Power Factor, Three-phase balanced systems, Star and delta Connections.

UNIT II MEASURING INSTRUMENTS AND SENSORS 9 hours

Operating Principle – Moving Coil and Moving Iron Instruments, Power Measurement, Energy Meter.Classification and characteristics of Sensors and Transducers; Types: proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, piezo electric crystals, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.

UNIT III ELECTRICAL MACHINES AND ELECTRICAL SAFETY 9 hours

Construction, working principle, and applications of DC Machines, Transformers, Three-phase Induction motors, Alternators, Stepper motor, and BLDC motor.
Electrical Safety and Precautions; Fuses and its types; Earthing and its types.

UNIT IV SEMICONDUCTOR DEVICES AND APPLICATIONS 9 hours

Introduction to Semiconductor materials, Characteristics: PN junction diodes, Zener diodes, BJTs; Applications: Rectifiers, Voltage regulator, and Public addressing system.

UNIT V DIGITAL ELECTRONICS 9 hours

Binary arithmetic; Number base conversion; Boolean algebra: simplification of Boolean functions using K-maps; Logic gates; Introduction of basic combinational circuits: Half adder, Full adder; Introduction to sequential circuits; Flip Flops.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Analyse simple DC and AC circuits using fundamental laws.
CO2: Operate measuring instruments and classify sensors used in systems.
CO3: Explain the working and applications of electrical machines and safety devices.
CO4: Apply semiconductor devices in basic power electronic circuits.
CO5: Design simple digital logic circuits using combinational and sequential elements.

Text Books:

1. Kothari DP and Nagrath IJ, "Basic Electrical and Electronics Engineering", McGraw Hill Education, Second Editions, 2020.
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
3. Bhattacharya SK, "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition,2017
4. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

Reference Books:

1. Rajendra Prasad 'Fundamentals of Electrical Engineering', Third Edition, Prentice Hall of India, 2014.
2. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
3. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
4. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year II Semester

25BAMECTC02 ENGINEERING MECHANICS

L	T	P	C
2	1	0	3

Pre-requisite: 25BAPHYTC01

Course Description:

This course provides a comprehensive introduction to engineering mechanics, covering both statics and dynamics. It begins with the study of force systems, equilibrium of particles and rigid bodies, and progresses to the analysis of pin-jointed trusses. Students will learn concepts of centroid, moments of inertia, and their applications in structural analysis. The course also covers friction, work-energy principles, and the kinematics and kinetics of particles and rigid bodies. Emphasis is placed on problem-solving and applying mechanical principles to real-world engineering situations.

Course Objectives:

This course is designed to:

1. Introduce the principles of mechanics for analyzing forces, moments, and equilibrium in particles and rigid bodies.
2. Develop analytical skills to solve engineering problems involving trusses and supports.
3. Impart knowledge on centroids, center of gravity, and moment of inertia for various geometries.
4. Enable application of friction principles and Work and Energy Principle to practical problems.
5. Apply dynamics principles to solve motion problems using different analytical methods.

UNIT I FORCE SYSTEMS 9 hours

STATICS OF PARTICLES Introduction to Mechanics - System of Units -Laws of mechanics - Lame's theorem - Parallelogram and triangular Law of forces -Resolution of coplanar forces – Free body diagram - Equilibrium of particles

STATICS OF RIGID BODY: Moment of a force - Varignon's theorem - Moments and Couples - Equivalent system of forces - Requirements of stable equilibrium - Equilibrium of Rigid bodies subjected to two, three and four force system.

UNIT II ANALYSIS OF PIN JOINTED TRUSSES 9 hours

Classification of trusses -Reactions at supports and connections -Types of loading – Reaction for Simply supported truss, Cantilever truss - Analysis of Trusses using method of joints and methods of sections (Simply supported truss, Cantilever truss).

UNIT III CENTROID AND MOMENTS OF INERTIA 9 hours

Center of Gravity and Centroid - Area and polar moment of inertia - Radius of Gyration -Parallel and Perpendicular Axis Theorems -Mass Moment of inertia - Problems on centroid and area moment of inertia of plane figures and buildup sections.

UNIT IV FRICTION AND WORK PRINCIPLES 9 hours

Classification of friction, Laws of friction, Angle of repose, Force required to move a body along horizontal and inclined planes, Analysis of ladder, wedge, and belt friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9 hours

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion - Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand and apply fundamental principles of statics to particles and rigid bodies (L4).
CO2: Analyze trusses and determine forces in members (L4).
CO3: Calculate centroids, centers of gravity, and moments of inertia for various shapes (L4).
CO4: Apply friction laws to solve practical engineering problems and apply the work-energy principles on a particle. (L4).
CO5: Apply dynamics principles to solve motion problems by various methods (L4).

Text Books:

1. Beer, F. P., Johnston, E. R., Mazurek, D. F., & Eisenberg, E. R. (2021). *Vector Mechanics for Engineers: Statics and Dynamics* (12th ed.). McGraw Hill.
2. Hibbeler, R. C. (2022). *Engineering Mechanics: Statics and Dynamics* (15th ed.). Pearson Education.

Reference Books:

1. Shames, I. H. (2020). *Engineering Mechanics: Statics and Dynamics*. Pearson.
2. Timoshenko, S., & Young, D. H. (2019). *Engineering Mechanics*. McGraw Hill.
3. Meriam, J. L., & Kraige, L. G. (2020). *Engineering Mechanics: Statics and Dynamics* (9th ed.). Wiley.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech I Year II Semester

25BAMECEC01 ENGINEERING GRAPHICS

L	T	P	C
2	0	2	3

Pre-requisite: None

Course Description:
This course introduces the fundamentals of Engineering Graphics and its applications, with hands-on practice using AutoCAD and Autodesk Fusion 360. It covers orthographic projection of points, lines, planes, and solids, including sectional views and surface developments. Students will learn to interpret and convert between isometric and orthographic views, as well as perform simple 2D drawings and 3D modelling. The course emphasizes visualization skills and technical drawing practices essential for engineering design and communication.

Course Objectives:
This course is designed to:

1. Provide fundamental knowledge of engineering graphics and its applications in design and communication.
2. Develop skills in orthographic projections of points, lines, planes, and solids.
3. Enable students to visualize and represent sections and development of engineering solids.
4. Familiarize students with isometric and orthographic views and their interconversion.
5. Introduce computer-aided design (AutoCAD and Autodesk Fusion 360) for 2D drafting and simple 3D modelling.

UNIT I INTRODUCTION **12 hours**

Introduction to Engineering Graphics and its Applications. Introduction to AutoCAD commands. Types of Lines, Dimensioning and Geometrical Constructions, Simple 2D drawings using AutoCAD.

UNIT II PROJECTIONS OF POINTS & LINES **12 hours**

Projection of points: Orthographic projections, notation system, positions and projection of points in four quadrants.
Projection of lines: Positions and projection of lines (inclined to one plane, HP/VP).

UNIT III PROJECTIONS OF PLANES & SOLIDS **12 hours**

Projection of planes: Positions and projection of planes (inclined to two planes, HP and VP).
Projection of solids: Projections of regular solids. (resting on HP and axis inclined to HP only).

UNIT IV SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES **12 hours**

Section of solids: Sectional view of regular solids (cutting plane inclined to HP) and its true shapes.
Development of Surfaces: Development of surfaces of regular solids (Prism and Pyramid only).

UNIT V ISOMETRIC, ORTHOGRAPHIC VIEWS AND SIMPLE 3D MODELLING **12 hours**

Conversion of isometric views into orthographic views and vice-versa.
3D Modelling: Introduction to 3D modelling. Simple 3D modelling using Autodesk Fusion 360. (Software practice only. Not for examination)

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Interpret and apply AutoCAD commands to create simple 2D engineering drawings.
CO2: Construct orthographic projections of points, lines, and planes in different quadrants.
CO3: Generate projections of solids, sectional views, and true shapes.
CO4: Develop surface diagrams of prisms and pyramids and apply them to practical applications.
CO5: Convert between isometric and orthographic views and create simple 3D CAD models using Fusion 360.

Text Books:

1. K.L. Narayana & P. Kannaiah, *Engineering Graphics*, 4th Edition, Scitech Publications, 2021.
2. K. Venugopal & V. Prabhu Raja, *Engineering Drawing + AutoCAD*, 7th Edition, New Age International, 2022.
3. Dhananjay A. Jolhe, *Engineering Drawing with an Introduction to AutoCAD*, 5th Edition, McGraw Hill Education, 2023.

Reference Books:

1. N.D. Bhatt & V.M. Panchal, *Engineering Drawing: Plane and Solid Geometry*, 56th Edition, Charotar Publishing House, 2023.
2. Shah, P.J., *Engineering Drawing*, 3rd Edition, Pearson Education, 2021.
3. Agrawal B. & Agrawal C.M., *Engineering Graphics*, 2nd Edition, Tata McGraw Hill, 2020.

Online Learning Resources:

1. National Programme on Technology Enhanced Learning (NPTEL), Engineering Graphics – IIT Kharagpur. Available at: https://nptel.ac.in/courses/11210560
2. Autodesk Education, AutoCAD & Fusion 360 Learning Resources. Available at: https://www.autodesk.com/education/edu-software/overview
3. Coursera, Engineering Drawing and Visualization – Georgia Tech. Available at: https://www.coursera.org/learn/engineering-drawing

Mode of Evaluation: Continuous Assessment, Mid Term Tests and End Semester Examination.

B. Tech I Year II Semester

25BACHELC01 ENGINEERING CHEMISTRY LABORATORY

L	T	P	C
0	0	2	1

Pre Requisites: NIL

Course Description:

This laboratory course provides practical exposure to essential techniques in modern materials, water chemistry, electrochemistry, polymers, and green chemistry. Students will gain hands-on experience in synthesizing nanomaterials and biopolymers, analyzing water and industrial samples, performing electrochemical measurements, and applying analytical methods for real-world engineering applications.

Course Objectives:

1. **To develop** experimental skills in the synthesis and characterization of nanomaterials, conducting polymers, and biopolymers.
2. **To train** students in analytical techniques for water quality assessment, industrial material analysis, and electrochemical measurements.
3. **To promote** environmentally sustainable laboratory practices, including green synthesis and safe handling of chemical materials.

From the following 18 experiments, students are required to perform any 10 using volumetric and/or instrumental methods of analysis. Wherever applicable, modeling software may also be used.

List of Experiments:

1. Preparation of a nanomaterial by precipitation method
2. Determination of Hardness of a groundwater sample
3. Synthesis of polyaniline conducting polymer
4. Estimation of alkalinity of water sample
5. Construction of a Galvanic cell and determination of cell emf & free energy
6. Conductometric titration of strong acid vs strong base
7. Conductometric titration of weak acid vs strong base
8. Electroless deposition of copper from copper sulphate solution
9. Estimation of Dissolved Oxygen by Winkler's method
10. Determination of strength of an acid in Pb-Acid battery
11. Estimation of Calcium in Portland Cement
12. Determination of molecular weight of a polymer by using Ostwald's viscometer
13. Determination of percentage moisture content in a coal sample
14. Estimation of iron in cement by colorimetry
15. Green synthesis of PVA/Starch biopolymer
16. Synthesis of PVA biopolymer
17. Potentiometry - determination of redox potentials and emfs
18. Determination of Saponification value of an oil sample

Course Outcomes:

CO1: Demonstrate the ability to synthesize and characterize nanomaterials, conducting polymers, and biopolymers.

CO2: Accurately determine water quality parameters, including hardness, alkalinity, and dissolved oxygen, using standard laboratory methods.

CO3: Construct and analyze electrochemical cells, perform potentiometric and conductometric titrations, and evaluate redox potentials.

CO4: Apply analytical techniques for the quantitative estimation of industrially relevant materials such as cement, coal, and oils.

CO5: Implement green chemistry principles in laboratory experiments, including biopolymer synthesis and environmentally friendly deposition techniques.

Reference Books:

1. Vogel's Textbook of Quantitative Chemical Analysis – J. Mendham, R.C. Denney, J.D. Barnes & M.J.K. Thomas, 6th Ed., Pearson Education, 2000.

2. Instrumental Methods of Chemical Analysis – B.K. Sharma, 23rd Ed., Goel Publishing House, 2007.

3. S. Choudhury, *Experiments in Nanomaterials, Electrochemistry and Green Chemistry*, Wiley, 2nd Edition, 2013.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination

B. Tech I Year II Semester

25BAEEELC01 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY

L	T	P	C
0	0	2	1

Pre requisites Nil

Course Description:

This laboratory course provides practical exposure to fundamental concepts of electrical and electronics engineering. Students perform experiments to verify basic circuit laws, measure power in three-phase systems, test electrical machines, and study transducers. The lab also includes the design and implementation of basic digital circuits, enabling learners to connect theoretical knowledge with real-world applications.

Course Objectives: By the end of this course, the student will be able to:

1. To understand and verify fundamental electrical circuit laws and theorems using basic circuit components.
2. To measure and analyze power consumption in different load configurations (Star and Delta).
3. To study the performance characteristics of electrical machines like transformers, DC motors, and induction motors through practical testing.
4. To explore the working principles and applications of key transducers such as LVDTs and strain gauges.
5. To design and implement basic digital logic circuits including gates, flip-flops, and adders.

List of Experiments:

1. Verification of Kirchhoff's Current Law (KCL) and Voltage Law (KVL)
2. Measurement of Active Power in Balanced Star and Delta Connected Loads
3. Speed Control of a DC Motor
4. Load Test on a Single-Phase Transformer
5. Load Test on a Three-Phase Induction Motor
6. Study and Operation of a Linear Variable Differential Transformer (LVDT)
7. Measurement of Strain Using a Resistance Strain Gauge
8. Implementation and Verification of Basic Logic Gates
9. Design and Testing of Flip-Flops
10. Design and Implementation of Binary Adders

Virtual Labs and content beyond syllabus

1. Generation of clock using NAND and NOR gate
2. To study the torque speed characteristics of three phase induction motor.

Course Outcomes: At the end of the course, the student will be able to

CO1: Apply and verify Kirchhoff's laws to analyze electrical circuits.

CO2: Measure active power in three-phase balanced loads using appropriate instruments.

CO3: Evaluate the performance of electrical machines and understand their practical applications.

CO4: Demonstrate the working and application of transducers such as LVDT and resistance strain gauges.

CO5: Design and implement fundamental digital circuits using logic gates, flip-flops, and adders.

Text Books:

1. Theraja, B.L. & Theraja, A.K. A Textbook of Electrical Technology Vol. I & II,S. Chand Publications
2. Hughes, Edward, Ian McKenzie Smith, John Hiley, Keith Brown, Electrical and Electronic Technology Pearson Education.
3. Boylestad, Robert L. & Nashelsky, Louis, Electronic Devices and Circuit Theory, Pearson Education
4. Morris Mano, M. & Ciletti, Michael D.,Digital DesignPearson Education.
5. Sawhney, A.K.,A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co.

Mode of Evaluation: Continuous Internal Evaluation, Model Test and End Semester Examination.

B. Tech I Year II Semester

25BACOMLC02 SCIENTIFIC COMPUTING LABORATORY

L	T	P	C
0	0	2	1

Pre-Requisite: Nil

Course Description:

This course trains students in Excel for data analysis and visualization, PowerPoint for scientific presentations, and simulation software for computational problem solving. The course covers numerical methods, simulations, and data visualization techniques. Students can develop proficiency in integrating multiple tools for technical reporting. This course enhances analytical, computational, and communication skills.

Course Objectives:

This course enables students to

1. Acquire proficiency in using spreadsheet tools for scientific data organization, analysis, and visualization.
2. Develop skills to design and deliver professional technical presentations using presentation software.
3. Apply computational software for basic programming, problem solving, and data processing.
4. Perform data handling, plotting, and visualization using computational tools.
5. Model and simulate simple scientific and engineering applications using computational techniques.

List of Experiments:

Module 1 – Spreadsheet for Scientific Computing

1. Introduction to spreadsheet interface, formulas, and functions.
2. Data organization, filtering, and conditional formatting.
3. Charts & graphs (line, bar, scatter, pie) and trendline analysis.
4. Basic statistical functions (mean, median, standard deviation, regression).

Module 2 – Presentation Software for Scientific Communication

5. Introduction to presentation software, slide master, and themes.
6. Adding and formatting charts, tables, and images from spreadsheet/computational tools.
7. Creating animations, transitions, and embedding media.
8. Preparing a professional project presentation integrating scientific results.

Module 3 – Basics of Computational Software

9. Introduction to computational environment, commands, and script/program files.
10. Array/matrix creation, manipulation, and operations.
11. Use of control statements (`if`, `for`, `while`) and vectorized operations.

Module 4 – Data Handling & Visualization

12. Importing/exporting data between spreadsheet and computational software.
13. Plotting 2D graphs (line, scatter, bar, stem) and customizing plots.
14. Creating 3D plots (mesh, surface, contour).

Module 5 – Applications & Simulation

15. Modeling simple physical phenomena (e.g., projectile motion).
16. Simulation of basic electrical/electronic systems (e.g., RC charging/discharging).
17. Population growth or decay models.
18. Mini-project: Integrating spreadsheet, computational, and presentation tools for scientific reporting.

Hardware Requirements:
Computers

Software requirements:
Spreadsheet software, Presentation software, and Computational/Programming software (e.g., MATLAB / Python / Octave / Scilab)

Course Outcomes:

Upon successful completion of the course, students will be able to

CO1: Use spreadsheet tools for organizing, analyzing, and visualizing scientific/engineering data.
CO2: Create professional scientific presentations using presentation software with integrated charts and media.
CO3: Develop programs and scripts to solve computational problems using appropriate software tools.
CO4: Perform data analysis and visualization using 2D/3D plotting features in computational software.
CO5: Simulate simple engineering and scientific applications and present results using integrated tools.

Text Books:

1. **Holly Moore**, *MATLAB for Engineers*, Pearson Education, 6th Edition, 2022.
2. **Amos Gilat** – MATLAB: An Introduction with Applications, 6th Edition, Wiley, **2017**.
3. **Faithe Wempen** – Microsoft Office 365: In Practice, 2019 Edition, McGraw-Hill Education, **2019**.
4. **Rudra Pratap -** Getting started with Simulation Software: A quick introduction for scientist & engineers by, Oxford, **2010**.
5. **Wayne L. Winston**, *Microsoft Excel Data Analysis and Business Modeling*, Microsoft Press, 5th Edition.

Reference Books:

1. **Brian Hahn & Daniel T. Valentine** – *Essential MATLAB for Engineers and Scientists*, 7th Edition, Academic Press, **2022**.
2. **Michael Alexander & Dick Kusleika** – *Excel 2021 Bible*, Wiley, **2021**.
3. **Jaan Kiusalaas** – *Numerical Methods in Engineering with MATLAB*, 4th Edition, Cambridge University Press, **2019**.
4. **Faithe Wempen**, *PowerPoint Bible*, Wiley, 3rd Edition.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination

B. Tech II Year I Semester

25BAMATTC06 PROBABILITY AND STATISTICS FOR ENGINEERS

L	T	P	C
3	0	0	3

Pre Requisites: 25BAMATTC01, 25BAMATTC03

Course Description:

This course provides a foundation in probability and statistics with emphasis on engineering applications. It covers probability theory, random variables, and standard probability distributions for modelling uncertainty. The course further includes joint distributions and regression for multivariate analysis, statistical inference through confidence intervals and hypothesis testing, and analysis of variance (ANOVA) with basic experimental design techniques for engineering applications.

Course Objectives:

1. To strengthen the fundamental concepts of probability and random variables.
2. To apply discrete and continuous probability distributions in engineering problem-solving.
3. To analyse multivariate data using joint distributions, correlation, and regression techniques.
4. To apply statistical inference methods including confidence intervals and hypothesis testing.
5. To understand and analyse engineering experimental designs using ANOVA techniques.

UNIT I PROBABILITY AND RANDOM VARIABLES 9 hours

Introduction to probability, sample space and events, axioms of probability, theorems on probability, conditional probability, multiplication theorem, independence of events, Bayes' theorem.

Random variables: discrete and continuous, probability density functions, cumulative distribution function and its properties. Expectation, properties of expectation, variance, moment generating function.

UNIT II PROBABILITY DISTRIBUTIONS 9 hours

Discrete distributions: Bernoulli trials, Geometric distribution, Binomial distribution, Poisson approximation to Binomial, Poisson distribution— properties and applications.

Continuous distributions: Uniform, Exponential, Gamma, and Normal distributions- properties and applications

UNIT III JOINT DISTRIBUTIONS AND REGRESSION ANALYSIS 9 hours

Joint probability distributions (discrete and continuous), marginal distributions, conditional distributions. Independence of random variables, expectation of joint distributions, covariance and correlation.

Regression analysis: simple linear regression, regression coefficients, lines of regression and their properties.

UNIT IV HYPOTHESIS TESTING AND STATISTICAL INFERENCE 9 hours

Population and sampling, sampling distributions, Central Limit Theorem. Estimation of parameters, confidence intervals. Formulation of null and alternative hypotheses, level of significance, Type I and Type II errors, power of a test. Large sample tests: single mean, single proportion, difference of means, difference of proportions. Small sample tests: t-test (single mean and difference of means), F-test for ratio of variances.

UNIT V ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS 9 hours

Analysis of Variance (ANOVA): one-way and two-way classification. Principles of experimental design: randomization, replication, and local control.Design of Experiments: Randomized Block Design (RBD) and Latin Square Design (LSD).

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Apply probability concepts and random variables to model engineering uncertainties.

CO2: Use appropriate probability distributions to solve engineering problems.

CO3: Analyse multivariate data using joint distributions, correlation, and regression techniques.

CO4: Apply statistical inference methods including confidence intervals and hypothesis testing.

CO5: Analyse engineering experiments using ANOVA and design of experiments techniques.

Text Books:

1. J.S. Milton and J.C. Arnold, Introduction to Probability and Statistics, 4th edition, 2003 Tata McGraw-Hill Publications.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.

Reference Books:

1. Sheldon M. Ross: Introduction to Probability and Statistics for Engineers and Scientists, 4th Edition, Elsevier, Academic Press, 2010.
2. Walpole, R.E., Myers R.H., Myer S.L., Ye. K: Probability and Statistics for Engineers and Scientists, 8th ed., Pearson Education, 2008.
3. Johnson, R.A. Miller Freund's: Probability and Statistics, 7th Edition, PHI, 2005.
4. Sheldon Ross: A First Course in Probability, 6th Edition, Pearson Education, 2002.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year I Semester

25BAMECTC03 ENGINEERING THERMODYNAMICS

L	T	P	C
2	1	0	3

Pre-requisite: Nil

Course Description:

This course introduces the fundamental laws and principles of thermodynamics and applies them to engineering systems such as compressors, turbines, IC engines, refrigeration systems, and power plants. Emphasis is placed on engineering problem-solving, industry-oriented applications, sustainability, energy efficiency, and readiness for roles in thermal engineering, HVAC, automotive, power generation and process industries.

Course Objectives:

This course is designed to:

1. Build a strong conceptual foundation on thermodynamic properties, laws, and processes.
2. Develop analytical skills to model and evaluate engineering systems used in power, refrigeration, and energy sectors.
3. Familiarize students with real-gas behavior, gas mixtures, combustion, and psychometrics relevant to industry applications.
4. Strengthen employability skills through emphasis on problem-solving, data interpretation, and application of concepts in thermal system design.

UNIT I BASIC CONCEPTS & FIRST LAW OF THERMODYNAMICS 9 hours

Definition and scope of thermodynamics; systems, control volume, boundaries. Thermodynamic properties, state, equilibrium, processes, and cycles. Zeroth law; temperature scales and measurement. Work and heat interactions; energy as a property. First Law for closed systems; internal energy; enthalpy.

UNIT II SECOND LAW OF THERMODYNAMICS & ENTROPY 9 hours

Limitations of the First Law; heat engines, refrigerators, heat pumps. Kelvin–Planck and Clausius statements; equivalence and violations. Reversible and irreversible processes; Carnot cycle—efficiency and COP. Clausius inequality; entropy definition and property relations. Entropy change for pure substances, ideal gases, and isentropic processes.

UNIT III PROPERTIES OF PURE SUBSTANCE & THERMODYNAMIC CYCLES 9 hours

P-V-T surfaces; property diagrams (T–S, H–S); steam tables & Mollier charts. Ideal and actual Rankine cycle; reheat and regeneration; boiler and turbine performance. Steam nozzles, wetness fraction, and quality measurements. Introduction to Brayton cycle: simple, intercooling, reheating, regeneration.

UNIT IV GAS MIXTURES, PSYCHROMETRY & COMBUSTION 9 hours

Ideal and real gas mixtures; Dalton law. Psychrometric properties: humidity ratio, specific humidity, DBT, WBT, RH, and enthalpy of moist air. Psychrometric chart & processes: heating, cooling, humidification, dehumidification. Combustion basics; stoichiometry, excess air, combustion efficiency, emission reduction.

UNIT V REFRIGERATION, IC ENGINES, COMPRESSORS & AI APPLICATIONS **9 hours**

Vapor compression refrigeration cycle ideal vs actual, COP. Refrigerants: properties, selection, environmental compliance (ASHRAE standards). Basic thermodynamics of IC engines: Otto, Diesel & Dual cycles efficiency and performance. Gas compressors: reciprocating and rotary types; multistage compression with intercooling. Real time AI applications in Refrigeration, IC Engines, Compressors.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Apply the First Law to thermodynamic systems.

CO2: Analyze entropy and thermodynamic cycles.

CO3: Analyze steam properties and power cycles.

CO4: Apply gas mixture, psychrometry, and combustion principles.

CO5: Evaluate refrigeration, IC engines, compressors, and AI applications.

Text Books:

1. **Yunus A. Çengel & Michael A. Boles**, *Thermodynamics: An Engineering Approach*, **10th Edition, 2024**, McGraw-Hill.
2. **P.K. Nag**, *Engineering Thermodynamics*, **6th Edition, 2023**, McGraw-Hill.
3. **M. Achuthan**, *Engineering Thermodynamics*, **Revised Edition 2022**, PHI Learning.

Reference Books:

1. **R. K. Rajput**, *Engineering Thermodynamics*, **6th Edition, 2023**, Laxmi Publications.
2. **Gordon J. Van Wylen, Sonntag & Borgnakke**, *Fundamentals of Thermodynamics*, **10th Edition, 2022**, Wiley.
3. **William C. Reynolds & P. M. Perkins**, *Thermodynamics*, **2021 Reprint**, McGraw-Hill.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year I Semester

25BAMECTC04 PRODUCT DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

Pre-requisite: Engineering Graphics

Course Description:

This course introduces the principles and methodologies involved in product design and development for engineering applications. It focuses on transforming customer needs into innovative and manufacturable products through systematic design approaches. The course covers concept generation, product architecture, material selection, CAD modeling, prototyping, testing, and product realization. Students gain knowledge in design thinking, sustainability, ergonomics, and product lifecycle management. Modern concepts such as additive manufacturing, digital manufacturing, and Industry 4.0 are also introduced. The course enables students to develop practical skills for industrial product innovation and engineering design applications.

Course Objectives:

The course aims to:

1. Introduce systematic product design and development methodologies.
2. Develop skills in customer-centric product innovation.
3. Apply engineering design principles in conceptual and detailed product development.
4. Integrate CAD, prototyping, manufacturing, sustainability, and ergonomics into product realization.
5. Familiarize students with industrial design practices, design thinking, and product lifecycle management.

UNIT I INTRODUCTION TO PRODUCT DESIGN AND DEVELOPMENT — 9 hours

Introduction to product design and development, evolution of product design, importance of new product development in industry, product life cycle, characteristics of successful products, product planning and opportunity identification, customer needs analysis, voice of customer (VOC), market survey techniques, product design specifications (PDS), quality function deployment (QFD), design thinking process, innovation strategies, bio inspired product design and case studies on successful engineering products.

UNIT II CONCEPT GENERATION AND CREATIVE DESIGN — 9 hours

Creative thinking and innovation in engineering design, idea generation techniques, brainstorming, morphological charts, TRIZ methodology, functional decomposition, concept generation methods, concept screening and concept scoring techniques, decision matrix methods, ergonomics and anthropometric considerations, industrial aesthetics, human-centered product design, sustainable design considerations during concept development, and product benchmarking techniques.

UNIT III ENGINEERING DESIGN AND PRODUCT ARCHITECTURE — 9 hours

Product architecture and configuration design, modular and integral product design, material selection for product development, engineering design considerations, CAD-based product modeling, assembly modeling, reliability and robust design concepts, failure mode and effects analysis (FMEA), design optimization basics, eco-design principles, sustainable product engineering.

UNIT IV PROTOTYPING, TESTING AND PRODUCT REALIZATION 9 hours

Prototype development methodologies, rapid prototyping techniques, additive manufacturing and 3D printing technologies, virtual prototyping concepts, reverse engineering fundamentals, product testing and evaluation methods, verification and validation procedures, product performance analysis, design iteration and refinement, product data management (PDM), product lifecycle management (PLM), digital manufacturing concepts.

UNIT V PRODUCT ECONOMICS, SUSTAINABILITY AND PRODUCT MANAGEMENT 9 hours

Cost estimation in product development, value engineering, product sustainability concepts, circular economy principles, green manufacturing practices, reliability and maintenance considerations, intellectual property rights (IPR), product commercialization strategies, product launch and marketing considerations, entrepreneurship in product development, start-up product innovation, techno-economic feasibility analysis, risk assessment in product development, and case studies on sustainable and commercially successful products.

Course Outcomes:

After successful completion of the course, students will be able to:

CO1: Understand the product development process and market-driven design requirements.

CO2: Apply creativity and design thinking tools for concept generation.

CO3: Develop engineering specifications and evaluate design alternatives.

CO4: Use CAD and prototyping tools for product realization.

CO5: Analyze manufacturability, sustainability, reliability, and economic feasibility of products.

Text Books:

1. Karl T. Ulrich & Steven D. Eppinger, *Product Design and Development*, McGraw Hill.
2. Kevin Otto & Kristin Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, Pearson.

Reference Books:

1. George Dieter & Linda Schmidt, *Engineering Design*, McGraw Hill.
2. Chitale & Gupta, *Product Design and Manufacturing*, PHI.
3. Stuart Pugh, *Total Design: Integrated Methods for Successful Product Engineering*, Addison Wesley.
4. Boothroyd, Dewhurst & Knight, *Product Design for Manufacture and Assembly*.
5. Online Learning Resources:
   NPTEL – Product Design and Development (IIT Roorkee)
   MIT OpenCourseWare – Product Design and Development
   Coursera – Product Design Courses

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year I Semester

25BAMECTC05 MECHANICS OF SOLIDS

L	T	P	C
2	1	0	3

Pre-requisite: Engineering Mechanics

Course Description:

This course introduces the fundamental concepts of stress, strain, elastic behavior of materials, shear force and bending moment in beams, torsion of circular shafts, deflection analysis, principal stresses, energy methods, and stability of columns. Emphasis is placed on developing analytical and computational skills essential for mechanical design, structural integrity assessment, and failure prediction. The syllabus integrates modern industry expectations such as material testing interpretation, design validation, and exposure to computational concepts.

Course Objectives:

This course is designed to:

1. Develop understanding of mechanics governing deformation and failure of solids.
2. Enable students to analyze stresses, strains, and structural responses under different loading conditions.
3. Introduce energy principles, torsional analysis, and bending theories used extensively in industrial design.
4. Provide problem-solving competence aligned with GATE and industrial expectations.
5. Prepare students for advanced courses such as Machine Design, FEM, and Structural Analysis.

UNIT I FUNDAMENTALS OF STRESS AND STRAIN 9 hours

Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

UNIT II SHEAR FORCE AND BENDING MOMENT DIAGRAM 9 hours

Definition of beam – Types of beams –Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of beam.

UNIT III FLEXURAL STRESS & SHEAR STRESS 9 hours

FLEXURAL STRESS : Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.

SHEAR STRESS: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

UNIT IV DEFLECTION OF BEAMS & TORSION 9 hours

DEFLECTION OF BEAMS: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Simulation software related to deflection of beams.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

UNIT V THICK & THIN CYLINDERS AND COLUMNS 9 hours

THIN & THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lame's equation – cylinders subjected to inside & outside pressures –compound cylinders. Simulation software related to Thin & Thick Cylinders.

COLUMNS:

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations

of Euler's Formula, Rankine's Formula

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Apply stress–strain concepts to material behavior.

CO2: Analyze shear force and bending moment diagrams.

CO3: Analyze bending and shear stresses in beams.

CO4: Apply beam deflection and torsion principles.

CO5: Evaluate thick cylinders and column stability.

Text Books:

1. Gere & Goodno, Mechanics of Materials, Cengage, 10th Edition, 2023.
2. Beer, Johnston, DeWolf & Mazurek, *Mechanics of Materials*, McGraw Hill, 9th Edition, 2021.
3. S. S. Bhavikatti, *Strength of Materials*, Vikas Publishing, 6th Edition, 2020.

Reference Books:

1. **Timoshenko & Gere**, *Mechanics of Materials*, **CBS Publishers**, **3rd Edition reprint, 2023**.
2. **B. C. Punmia**, *Strength of Materials*, **Laxmi Publications**, **2022 Edition**.
3. **R. K. Rajput**, *Strength of Materials*, **S. Chand Publications**, **2021 Edition**.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year I Semester

25BAMECTC06 MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

Pre-requisite: None

Course Description:

This course introduces the scientific principles and industrial practices of major manufacturing processes excluding machining and additive manufacturing. It covers metal casting, metal forming, joining, powder metallurgy, plastics and composites processing, surface engineering, and quality/inspection fundamentals. Emphasis is placed on process selection, defect analysis, sustainability, safety, and manufacturability considerations aligned with modern industry requirements.

Course Objectives:

This course is designed to:

1. Introduce students to the scientific principles and practical considerations of metal casting and solidification processes.
2. Develop a strong conceptual foundation in bulk and sheet metal forming processes ,focusing on deformation behavior, formability, force requirements, defects, and industrial applications relevant to automotive and aerospace sectors.
3. Provide in-depth knowledge of welding, brazing, soldering, and solid-state joining processes, emphasizing joint design, material compatibility, defect analysis, and modern inspection techniques used in fabrication industries.
4. Enhance students' understanding of polymer, composite, and ceramic processing methods, covering manufacturing routes, processing parameters, defects, and their role in lightweight structures, electronics, and advanced engineering systems.
5. Introduce powder metallurgy, surface engineering, and essential industrial quality practices, equipping students to evaluate material–process relationships, surface modification strategies, and inspection tools essential for ensuring product performance and reliability.

UNIT I METAL CASTING PROCESS 9 hours

Differences between Metals and Non-Metals. Casting fundamentals: fluidity, shrinkage, gating and riser design (basic design principles only). Molding materials & methods: sand casting, shell, investment, die casting, centrifugal casting. Solidification of pure metals and alloys: nucleation, cooling curves, Chvorinov's rule. Casting defects: causes, detection, prevention; industrial case studies. Process economics, quality, sustainability & safety practices in foundries.

UNIT II BULK & SHEET METAL FORMING PROCESSES 9 hours

Classification of metal forming processes; formability concepts. Bulk deformation: forging (open/closed die), rolling, extrusion, drawing — principles, force/deformation analysis (basic), defects. Sheet metal forming: shearing, bending, deep drawing, stretch forming. High-energy-rate forming: explosive forming, electromagnetic forming. Material selection, lubrication, process limitations; industry applications (automotive, aerospace).

UNIT III METAL JOINING PROCESSES 9 hours

Overview of fusion and solid-state joining processes. Fusion welding: arc welding processes (SMAW, GMAW, GTAW), resistance welding. Solid-state welding: friction welding, friction stir welding, diffusion bonding, ultrasonic welding. Brazing & soldering: materials, fluxes, joint design. Weldability

of steels, aluminum & composites. Defects in welding & NDT methods (RT, UT, PT, MT). Introduction to ASME section V & IX.

UNIT IV POLYMER, COMPOSITE & CERAMIC PROCESSING 9 hours

Polymer processing: injection molding, compression molding, extrusion, blow molding, thermoforming. Rubber processing: vulcanization, calendaring. Composite manufacturing: hand layup, spray-up, filament winding, pultrusion, resin transfer molding (RTM), autoclave processing. Ceramic processing: powder preparation, forming methods (dry pressing, slip casting, tape casting), sintering. Process parameters, defects, quality control, and typical engineering applications.

UNIT V POWDER METALLURGY, SURFACE ENGINEERING 9 hours

Powder Metallurgy: powder production, characterization, blending, compaction, sintering, secondary operations; applications in automotive, aerospace, biomedical. **Surface engineering processes:** Electroplating, electroless plating, Anodizing, Thermal spray coatings, Carbon emission coating, Chemical vapor deposition (CVD), physical vapor deposition (PVD), Heat treatment process overview (hardening, carburizing, nitriding).

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Explain metal casting processes and defects.

CO2: Analyze metal forming processes and applications.

CO3: Apply metal joining methods and inspection techniques.

CO4: Apply polymer, composite, and ceramic processing methods.

CO5: Evaluate powder metallurgy and surface engineering processes.

Text Books:

1. S. Kalpakjian & S. Schmid – *Manufacturing Engineering and Technology*, 8th Edition, 2020, Pearson.
2. M. P. Groover – *Fundamentals of Modern Manufacturing*, 7th Edition, 2024, Wiley.
3. R. A. Higgins – *Materials and Manufacturing Processes*, Revised Edition 2021, New Age International.

Reference Books:

1. G. Dieter & P. Deutschman – *Mechanical Metallurgy*, SI Metric Edition Reprint 2021, McGraw-Hill.
2. Flinn & Trojan – *Engineering Materials and Their Applications*, 8th Edition, 2019, Wiley.
3. Kutz, M. – *Handbook of Manufacturing Engineering*, 4th Edition, 2019, McGraw-Hill.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year I Semester

25BAMECLC01 MECHANICS OF SOLIDS AND MATERIALS SCIENCE LABORATORY

L	T	P	C
0	0	2	1

Pre-requisite: Engineering Mechanics, Basic Materials Science

Course Description:

This laboratory provides hands-on experience with the mechanical behavior of engineering materials, including metals, polymers, composites, and ceramics. Students will learn standard testing methods, characterization tools, data interpretation, and report writing aligned with industrial practices (ASTM, ISO). The course enhances practical skills required for careers in manufacturing, product design, quality control, materials testing, and research laboratories.

Course Objectives:

This course is designed to:

1. Introduce students to experimental methods used in evaluating mechanical properties of materials.
2. Familiarize students with standard testing procedures, instrumentation, calibration, and data acquisition.
3. Enable students to analyze stress–strain behavior and correlate it with material structure and applications.
4. Enhance employability skills through industrial testing practices, interpretation of test certificates, and error analysis.
5. Develop competency in material characterization tools essential for modern engineering industries.
6. Reinforce theoretical concepts learned in Mechanics of Solids and Materials Science theory courses.

List of Experiments

A) Mechanics of Solids Experiments:

1. Tensile test
2. Bending test on
   a) Simply supported beam
   b) Cantilever beam
3. Torsion test
4. Hardness test
   a) Rockwell hardness test
   b) Vickers hardness test
5. Impact test
   a) Charpy test
   b) Izod test
6. Double shear test

B) Materials Science Experiments:

1. Specimen preparation for micro-structural examination – Cutting, Grinding, Polishing, Etching.
2. Preparation and study of the Microstructure of Mild steel, Medium carbon steels, and High carbon steels.
3. Study of the Microstructures of Cast Irons.
4. Study of the Microstructures of Non-Ferrous alloys.
5. Study of the Microstructures of steels post heat treatment process.
6. Hardenability of steels by Jominy End Quench Test.
7. Study of Spectrometry analysis.

Content beyond Syllabus (Virtual laboratory)
https://sm-nitk.vlabs.ac.in

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Perform standard mechanical and materials testing procedures following industrial norms (ASTM/ISO).

CO2: Analyze stress–strain curves and evaluate material properties such as strength, hardness, toughness, and stiffness.

CO3: Correlate mechanical properties with microstructure, heat treatment, and material composition.

CO4: Utilize modern instruments (UTM, hardness testers, microscopes, NDT tools) for characterization and quality evaluation.

CO5: Interpret experimental data, prepare technical reports, and recommend suitable materials for engineering applications.

Text Books:

1. William D. Callister & David G. Rethwisch, *Materials Science and Engineering: An Introduction*, 11th Edition, 2023, Wiley.
2. Ferdinand P. Beer & E. Russell Johnston, *Mechanics of Materials (Lab Companion References)*, 10th Edition, 2022, McGraw-Hill.
3. V. Raghavan, *Materials Science and Engineering*, 6th Edition, 2022, PHI Learning.

Reference Books:

1. George E. Dieter & Linda C. Schmidt, *Mechanical Metallurgy*, 5th Edition, 2023, McGraw-Hill.
2. Lawrence H. Van Vlack, *Elements of Materials Science & Engineering*, Latest Reprint 2022, Pearson.
3. S. Kalpakjian & Steven Schmid, *Manufacturing Engineering and Technology* (Testing & Materials Sections), 8th Edition, 2023, Pearson.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech II Year I Semester

25BAMECLC02 MANUFACTURING PROCESSES LABORATORY

L	T	P	C
0	0	2	1

Pre-requisite: **Manufacturing Processes, Engineering Skills Laboratory**

Course Description:

A hands-on laboratory course that gives students practical exposure to primary and secondary manufacturing processes (casting, forming, joining, sheet metal operations), inspection and allied processes. The lab emphasizes process parameter selection, quality checks, safety, shop-floor documentation, and mini-project/problem solving to prepare students for entry-level roles in manufacturing, production engineering, quality, and process planning departments.

Course Objectives:

This course is designed to:

1. Provide practical experience in common production processes: casting, welding, forming, machining and sheet metal.
2. Train students to plan and execute experiments, record process parameters, and interpret process–property relationships.
3. Develop skills in machine setup, tool selection, parameter optimization and part inspection using metrology instruments.
4. Instill shop-floor safety, quality checks, process documentation, and team-based mini project execution — all aimed at employability.

List of Experiments

1. METAL CASTING LAB:
   a. Pattern Design and making – for one casting drawing.
   b. Sand properties testing - Exercise - for strengths, and permeability
   c. Moulding: Melting and Casting
2. WELDING LAB:
   Arc Welding: Lap & Butt Joint
   a. Spot Welding
   b. TIG Welding
   c. MIG welding
   d. Brazing
3. MECHANICAL PRESS WORKING:
   a. Blanking & Piercing operation and study of simple, compound and progressive press tool.
   b. Hydraulic Press: Operation –Forming exercise.
4. FORGING:
   a. Preparation of simple forging model involving upsetting and bending operations.
5. PROCESSING OF PLASTICS & COMPOSITE:
   a. Injection Moulding
   b. Fabrication of Composite plate

Content beyond Syllabus (Virtual laboratory)

https://sm-nitk.vlabs.ac.in

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Perform metal casting operations safely.

CO2: Perform welding processes and inspect joints.

CO3: Analyze press working operations and product quality.

CO4: Evaluate forged components and process parameters.

CO5: Fabricate polymer and composite products.

Text Books:

1. **Serope Kalpakjian & Steven R. Schmid**, *Manufacturing Engineering and Technology*, **9th Edition, 2025**, Pearson.
2. **Mikell P. Groover**, *Fundamentals / Principles of Modern Manufacturing*, **SI Edition.**
3. V. Raghavan, *Materials Science and Engineering*, 6th Edition, 2022, PHI Learning.

Reference Books:

1. **R.K. Jain**, *Production Technology (Manufacturing Processes)*.
2. **Heinz P. Bloch & Fred K. Geitner**, *Manufacturing Process.*
3. S. Kalpakjian & Steven Schmid, *Manufacturing Engineering and Technology* (Testing & Materials Sections), 8th Edition, 2023, Pearson.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech II Year I Semester

25BAMECLC03 COMPUTER AIDED MACHINE DRAWING LABORATORY

L	T	P	C
0	0	2	1

Pre-requisite: Engineering Graphics

Course Description:

This laboratory course introduces students to computer-aided machine drawing using CAD software widely used in industry (e.g., AutoCAD, SolidWorks, Creo, Siemens NX). Students develop skills in preparing and interpreting engineering drawings, visualization of parts/assemblies, dimensioning and tolerancing as per international standards, and creation of manufacturing-ready documentation. Focus is on industry practices, engineering visualization, geometric dimensioning & tolerancing (GD&T), basic assembly modeling, and drawing automation to support modern mechanical design workflows.

Course Objectives:

At the end of the course, the student will be able to:

1. Understand and apply CAD fundamentals to create accurate machine drawings per engineering standards.
2. Develop part models and assembly drawings with correct constraints, annotations, and documentation.
3. Interpret and apply dimensioning, tolerancing, sectioning, and projection techniques to convey design intent.
4. Use CAD tools to produce drawings ready for manufacturing, inspection, and assembly.
5. Enhance employability skills by working with industry-relevant exercises and real-world components.

List of experiments

1. Introduction to 2D and 3D modelling
2. Drawing of Detachable Joints: bolt and nut with different screw thread
3. Drawing of Riveted Joints for Plates
4. Drawing of Welded Joints
5. Assembly of Shaft Coupling
6. Assembly of Universal Joint
7. Assembly of Knuckle Joint
8. Assembly of Butterfly Valve
9. Assembly of Screw Jack
10. Assembly of Plummer Block
11. Assembly of Machine vice

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand CAD fundamentals and drawing standards.

CO2: Apply CAD tools to create 2D orthographic and sectional drawings.

CO3: Model complex 3D parts with appropriate features, constraints, and parametrics.

CO4: Assemble parts, create detailed assembly drawings, and prepare BOM.

CO5: Interpret advanced engineering drawings and produce manufacturing-ready documentation.

Text Books:

1. M. Sham Tickoo, *AutoCAD for Engineering Graphics*, 2025 Edition, CADCIM Technologies.
2. David A. Madsen & David P. Madsen, *Engineering Drawing & Design with AutoCAD 2025*, 8th Edition, 2024, Cengage Learning.
3. James D. Bethune, *Technical Graphics with Engineering Graphics Workbook Using Autodesk Inventor & AutoCAD*, 4th Edition, 2023, Prentice Hall.

Reference Books:

1. G. Rogers & A. Adams, *Engineering Graphics with SolidWorks 2025*, 2nd Edition, 2024, McGraw-Hill.
2. Aslam Kassimali, *Engineering Graphics with AutoCAD 2025*, 16th Edition, 2024, Pearson.
3. Ellis & Nobles, *Engineering Drawing with Worked Examples*, 4th Edition, 2023, Elsevier.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

II Year II Semester

B. Tech II Year II Semester

25BAMATTC10 NUMERICAL METHODS

L	T	P	C
3	0	0	3

Pre Requisites: 25BAMATTC01, 25BAMATTC03

Course Description:

This course reviews and continues the study of computational techniques for solving system of algebraic and transcendental equations, interpolating the polynomials, evaluating the derivatives, integrals, ordinary differential equations and curve fitting. The course emphasizes on numerical and mathematical methods of solutions.

Course Objectives:

1. To introduce computation methods of solving algebraic and transcendental equations.
2. To familiarize the knowledge of interpolation.
3. To avail the basics of numerical techniques in calculus
4. To use numerical methods for solving ordinary differential equations.
5. To introduce the empirical techniques for fitting the various curves.

UNIT I SOLUTIONS OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS 9 hours

Introduction-Bisection method - Regula-falsi method - Iterative method - Newton Raphson method, System of Algebraic equations: Gauss Jacobi method - Gauss Seidal method.

UNIT II FINITE DIFFERENCES AND INTERPOLATION 9 hours

Finite differences, Newton's forward and backward interpolation formulae - Gauss forward and backward formulae, Stirling's formula, Bessel's formula - Lagrange's and Newton's divided difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9 hours

Formulae for derivatives, Maxima and minima of a tabulated function. Numerical Integration: Trapezoidal rule - Simpson's 1/3 Rule - Simpson's 3/8 Rule

UNIT IV NUMERICAL SOLUTIONS TO ORDINARY DIFFERENTIAL EQUATIONS 9 hours

Picard's Method - Taylor's series method - Euler's method - Modified Euler's Method - Runge-Kutta Method.

UNIT V CURVE FITTING 9 hours

Introduction - Graphical method - Principle of least squares - Method of least squares - Fitting of straight line and parabola - Fitting of exponential and power curves.

Course Outcomes:

At the end of this course students will demonstrate the ability to

CO1: Solve the system of algebraic and transcendental equations.
CO2: Interpolate the equal and unequal spaced arguments of function.
CO3: Apply the numerical techniques to find derivatives and integrals in the field of Engineering
CO4: Find the approximate numerical solutions to ordinary differential equations representing some Engineering problems.
CO5: Estimate the model parameters using the principles of least squares to a curve of best fit for the experimental observations.

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.

Reference Books:

1. Curtis F. Gerald, Patrich O. Wheatley, Applied Numerical Analysis, Pearson Education, 7th Edition, 2003.
2. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005
3. Burden and Faires, Numerical Analysis 7th edition, Thomson Learning, 2001.
4. E. Kreyszig, Advanced Engineering Mathematics, 10th edition, Wiley, 2010.
5. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering, New Age International Ltd., 5th Edition, 2010.
6. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists 3rd edition, Mc Graw Hill, 2012.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year II Semester

25BAMECTC07 MACHINE TOOLS AND METROLOGY

L	T	P	C
3	0	0	3

Pre-requisite: None

Course Description:

This course focuses on modern machine tools, machining processes, CNC/NC systems, tooling, cutting mechanics, metrology principles, precision measurement systems, surface characterization, GD&T, statistical quality control, and industrial inspection technologies. Emphasis is placed on industrial practices, automation, digital metrology, certification readiness, and skills aligned with employability in design, manufacturing, and quality engineering roles.

Course Objectives:

This course is designed to:

1. Introduce the principles, construction, and working of conventional and modern machine tools to build a strong foundation in manufacturing processes required in the mechanical engineering industry.
2. Develop an understanding of metal cutting mechanics, cutting tool materials, machining parameters, and process optimization to enhance decision-making skills for real-world machining applications.
3. Enable students to acquire hands-on knowledge of CNC technology, automation, tooling systems, and CAD/CAM integration, improving their employability in advanced manufacturing sectors.
4. Familiarize students with fundamental and advanced metrology concepts, including precision measurement systems, surface and form measurement, and calibration practices based on ISO/ASME standards.
5. Equip students with competencies in GD&T, coordinate metrology, inspection methods, and statistical quality control, preparing them for roles in quality assurance, production, and design engineering.

UNIT I FUNDAMENTALS OF MACHINE TOOLS & MACHINING MECHANICS — 9 hours

Introduction to machine tools: roles in manufacturing, current industry demands. Mechanics of metal cutting: orthogonal cutting, merchant analysis, chip formation, cutting forces, tool wear, tool life (Taylor equation). Cutting tool materials: HSS, carbides, ceramics, cermets, coated tools, PCD/CBN; selection criteria. Cutting fluids: types, application methods, sustainability considerations. High-speed machining (HSM), hard machining, dry/mist machining. Productivity, machinability indices, process parameter optimization (DoE concepts).

UNIT II CONVENTIONAL MACHINE TOOLS & OPERATIONS — 9 hours

Lathe machine: construction, work holding, turning, threading, taper turning, boring; industrial tolerances. Drilling & allied operations: drilling, reaming, tapping; drill tool geometry, accuracy issues. Milling operations: slab, face, end milling; up/down milling; cutters and tool holding. Shaping, planning, slotting machines: Grinding processes: surface, cylindrical, centerless, abrasive types, grinding wheel selection.

UNIT III ADVANCED MACHINING PROCESSES — 9 hours

Introduction to advanced machining processes. Classification, working principle, applications and limitations of AJM, UM, ECM, EDM, WEDM, LBM, EBM & IBM. Hard Machining and High-Speed Machining.

UNIT IV METROLOGY & PRECISION MEASUREMENT SYSTEMS 9 hours

Overview of metrology: precision vs. accuracy, traceability, calibration. Linear & angular measurement tools: slip gauges, dial indicators, autocollimators, angle gauges. Limit system & fits: hole- and shaft-basis systems, ISO tolerance grades. Gauges: GO/NO-GO gauges, gauge design principles, gauge calibration. Interferometry: optical flats, fringe interpretation, industrial applications. Surface metrology: surface roughness parameters (Ra, Rz, Rq), profilometers, 3D optical surface measurement. Form measurement: roundness, cylindricity, straightness, flatness.

UNIT V GD&T, QUALITY ASSURANCE & ADVANCED METROLOGY 9 hours

Geometric Dimensioning & Tolerancing (GD&T): symbols, datums, tolerance zones, feature control frames. Inspection strategies: CMM (Cartesian & articulated arm) fundamentals, probing systems, programming basics. Coordinate metrology: error sources, compensation, best-fit algorithms. Statistical Quality Control (SQC): control charts, process capability (Cp, Cpk), measurement system analysis (MSA). Machine vision & non-contact metrology: laser scanning, white light scanning, machine vision inspection. Metrology in smart factories: IoT-enabled measurement, automated inspection cells, digital traceability. Industrial standards: ISO 1101, ASME Y14.5, ISO GPS principles.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Explain the working principles of machine tools and mechanics of machining processes.

CO2: Select appropriate tools, machining parameters, and operations for industrial applications.

CO3: Interpret and use metrological instruments and standards for precision measurement.

CO4: Apply precision measurement and metrology techniques.

CO5: Apply GD&T, statistical quality techniques, and advanced metrology methods for inspection and quality assurance.

Text Books:

1. R.K. Jain, *Engineering Metrology*, 21st Edition, Khanna Publishers, 2023.
2. S. Kalpakjian & S.R. Schmid, *Manufacturing Processes for Engineering Materials*, 7th Edition, Pearson, 2022.
3. G.C. Sen & A. Bhattacharya, *Principles of Machine Tools*, 3rd Edition, New Age International, 2023.

Reference Books:

1. Mikell P. Groover, *Fundamentals of Modern Manufacturing*, 8th Edition, Wiley, 2024.
2. Peter J. Hannam, *Fundamentals of Dimensional Metrology*, 7th Edition, Cengage, 2023.
3. Eric Oberg, *Machinery's Handbook*, 32nd Edition, Industrial Press, 2024.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year II Semester

25BAMECTC08 FLUID MECHANICS AND HYDRAULIC MACHINES

L	T	P	C
3	0	0	3

Pre-requisite: Nil

Course Description:

This course introduces the fundamental principles of fluid statics, kinematics, and dynamics, followed by the design and performance evaluation of hydraulic machinery. The syllabus emphasizes industry-aligned competencies, including application of fluid principles in CFD, energy systems, turbomachinery, water resource engineering, and industrial hydraulics. Students gain analytical, computational, and problem-solving skills essential for core mechanical industries, utilities, R&D, and competitive exams.

Course Objectives:

This course is designed to:

1. Provide foundational knowledge of the properties, behavior, and governing equations of fluids.
2. Develop analytical skills for solving fluid flow problems encountered in mechanical and thermal industries.
3. Introduce hydraulic turbines, pumps, and systems with emphasis on performance evaluation and selection.
4. Enhance employability through exposure to industry practices, CFD-relevant concepts, and modern hydraulic applications.

UNIT I FLUID PROPERTIES AND FLUID STATICS 9 hours

Properties of a Fluid, Newton's law of viscosity, Surface Tension and Capillarity, Pressure, Hydrostatic law, Manometry, Hydrostatic forces acting on submerged surfaces, Buoyancy and Stability, Hydrostatic forces.

UNIT II FLUID KINEMATICS AND DYNAMICS 9 hours

System and Control volume, Classification of flows, Lagrangian and Eulerian descriptions, Acceleration, Streamlines, Path lines and Streak lines, Fluid body motion, Conservation of mass, Stream function, Body and surface forces, Reynold Transport Theorem, Euler's Equation, Bernoulli's Equation, Venturimeter and Orifice meter, Application of Momentum equation on pipe bends.

UNIT III INTERNAL AND EXTERNAL FLOW 9 hours

Laminar flow in ducts, Turbulent flow in ducts, Minor and Major losses, Pipe Networks, Flow over flat plate, Boundary layer equations, Displacement, Momentum and Energy thicknesses, Momentum integral technique for boundary layers.

UNIT IV HYDRAULIC TURBINES 9 hours

Classification, components, and velocity triangles for Pelton, Francis, and Kaplan turbines. Work done, efficiency, performance parameters, characteristic curves. Governing of turbines, cavitation and erosion (industry case-based). Model testing and similarity laws. Modern developments: pumped storage plants, small hydro turbines, digital monitoring.

UNIT V HYDRAULIC PUMPS & SYSTEMS 9 hours

Reciprocating pumps: working, indicator diagrams, acceleration head, air vessels. Centrifugal pumps: construction, Euler's equation, velocity triangles, NPSH, cavitation, priming, characteristic curves. Pump selection criteria for industry applications; pump–turbine interaction in hydro systems. Industrial hydraulics: hydraulic circuits, valves, accumulators, actuators—basic design concepts. Introduction to computational tools used in pump design (qualitative).

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Explain fluid properties, classification, statics, and kinematics with engineering relevance. *(Understanding – Level 2)*

CO2: Apply governing equations of fluid motion to solve internal and external flow problems. *(Apply – Level 3)*

CO3: Analyse open channel flow, boundary layer behaviour, and flow measurement systems. *(Analyse – Level 4)*

CO4: Evaluate performance of hydraulic turbines through velocity triangles, efficiencies, and characteristic curves. *(Evaluate – Level 5)*

CO5: Design and assess pump systems and hydraulic circuits for industrial applications. *(Create – Level 6)*

Text Books:

1. Y. A. Çengel & J. M. Cimbala, *Fluid Mechanics: Fundamentals and Applications*, 5th Edition, 2023, McGraw Hill.
2. R. K. Bansal, *A Textbook of Fluid Mechanics & Hydraulic Machines*, Revised Edition, 2022, Laxmi Publications.
3. P. N. Modi & S. M. Seth, *Hydraulics and Fluid Mechanics Including Hydraulic Machines*, 22nd Edition, 2023, Standard Book House.

Reference Books:

1. Frank M. White, *Fluid Mechanics*, 9th Edition, 2024, McGraw Hill.
2. J. F. Douglas, J. M. Gasiorek et al., *Fluid Mechanics*, 8th Edition, 2023, Pearson.
3. S. K. Som & G. Biswas, *Introduction to Fluid Mechanics and Fluid Machines*, 3rd Edition, 2021, McGraw Hill.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year II Semester

25BAMECTC09 THEORY OF MACHINES

L	T	P	C
3	0	0	3

Pre-requisite: Engineering Mechanics

Course Description:

This course deals with the study of kinematics and dynamics of machines, enabling students to understand the motion, forces, and control mechanisms that govern mechanical systems. Emphasis is placed on practical applications used in automotive systems, industrial machinery, automation, and robotics, with a focus on simulation-based analysis and troubleshooting skills. The course prepares students for job roles in design, manufacturing, maintenance, automation, and product development.

Course Objectives:

This course is designed to:

1. Introduce the fundamental concepts of mechanisms, kinematic pairs, and mobility to model real engineering systems.
2. Develop the ability to analyze velocity and acceleration in mechanisms using analytical, graphical, and computational tools.
3. Enable students to understand dynamic force analysis, energy relations, and balancing of rotating and reciprocating components.
4. Explain the principles of governors, gyroscopes, and control mechanisms relevant to modern automotive and industrial systems.
5. Build strong conceptual foundations in mechanical vibrations and their mitigation for reliability and safety.

UNIT I KINEMATICS OF MECHANISMS 9 hours

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom– Grashof law; kinematic inversions of four bar chain and slider crank chains; Limit positions – Mechanical advantage- Transmission angle; Quick return mechanism, Straight line mechanism.

UNIT II VELOCITY, ACCELERATION ANALYSIS AND CAMS 9 hours

Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centres, velocity and acceleration analysis using loop closure equations. Cams: Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions. Cam Layout.

UNIT III DYNAMICS OF MACHINES & BALANCING 9 hours

Dynamic force analysis of four-bar and slider-crank mechanisms. Turning moment diagrams, flywheel selection, fluctuation of energy. Balancing of rotating masses: Static and dynamic balancing. Balancing of reciprocating masses; partial balancing in engines.

UNIT IV GOVERNORS, GYROSCOPES 9 hours

Governors: Porter, Proell, Hartnell; controlling force curves; stability and sensitivity. Speed control in IC engines, turbines, generators. Gyroscopic principles and effects on aircraft, novel ships and motorcycles. Gyroscopic stabilization in drones / robotics.

UNIT V MECHANICAL VIBRATIONS 9 hours

Types of vibrations: Free, forced, damped, undamped. Single Degree of Freedom (SDOF) systems: Natural frequency, damping ratio. Forced vibrations with harmonic excitation; resonance. Introduction to vibration isolation, transmissibility, and industrial case studies.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Explain the fundamentals of mechanisms and mobility and apply them to model engineering systems. *(Understanding – Level 2)*

CO2: Analyze kinematic behaviour (velocity & acceleration) of mechanisms using analytical and simulation tools. *(Application – Level 3)*

CO3: Perform dynamic force analysis and balancing for rotating and reciprocating machinery. *(Analysis – Level 4)*

CO4: Evaluate the performance of governors and gyroscopic systems used in automotive and industrial applications. *(Analysis/Evaluation – Level 4/5)*

CO5: Model and interpret vibration characteristics of mechanical systems and propose mitigation techniques. *(Evaluate/Create – Level 5/6)*

Text Books:

1. S. S. Rattan, *Theory of Machines*, 5th Edition, McGraw-Hill, 2022.
2. R. K. Bansal, *Theory of Machines*, Latest Reprint 2021, Laxmi Publications.
3. J.E. Shigley & Uicker, *Theory of Machines and Mechanisms*, 5th Edition, Oxford University Press, 2020.

Reference Books:

1. Thomas Bevan**,** *Theory of Machines*, CBS Publishers, Reprint 2020.
2. Ghosh & Mallik, *Theory of Mechanisms and Machines*, 4th Edition, 2023, Affiliated East-West Press.
3. R.L. Norton, *Kinematics and Dynamics of Machinery*, 4th Edition, McGraw-Hill, 2019.

Mode of Evaluation: Assignments, Mid Term Tests and End Semester Examination.

B. Tech II Year II Semester

25BAMECLC04 MACHINE TOOLS AND METROLOGY LABORATORY

L	T	P	C
0	0	2	1

Pre-requisite: **Manufacturing Processes**

Course Description:

Practical exposure to conventional machine tools (lathe, milling, drilling, grinding, shaping), testing/acceptance checks for machine tools, basic fitting/manufacturing operations and hands-on skill training in mechanical measurements and industrial metrology (linear/angular measurement, surface finish, gear metrology, alignment tests, calibration). Emphasis on interpretation of measurement data, uncertainty, traceability and basic quality control to make students industry-ready for roles in manufacturing, quality inspection and maintenance.

Course Objectives:

This course is designed to:

1. Provide hands-on practice on conventional machine tools and common machining operations used in industry (turning, facing, milling, drilling, grinding).
2. Train students to perform machine-tool acceptance and alignment tests and interpret results for corrective action.
3. Teach use and calibration of linear/angular measuring instruments, comparators, profile projectors, surface finish testers and gear/roundness measuring instruments.
4. Develop ability to perform basic quality checks (statistical sampling, gauge repeatability & reproducibility) and report measurement uncertainty & traceability.
5. Build employable shop-floor skills: setup, tool selection, part inspection, measurement reporting and safety practices.

List of Experiments

PART A — Machine Tools Practicals

1. Lathe operation: Turning and Facing; Single-point tool geometry
2. Lathe: Thread cutting (metric) and knurling
3. Drilling & Tapping operations (Drilling machine + tools)
4. Milling: Slotting, face milling and key-way cutting
5. Gear cutting (simple gear generation on milling)
6. Shaping / Slotting: Internal slot and plain surface generation
7. Surface Grinding
8. Machine Tool Alignment Tests: Lathe & Milling Machine alignment

PART B — Metrology & Measurement Practicals

1. Linear measurement & calibration: Vernier caliper, micrometer, depth micrometer, height gauge
2. Bore/inside measurement: bore gauge, internal micrometer
3. Surface roughness measurement (portable stylus instrument)
4. Gear tooth measurement & inspection (Chordal addendum / thickness by gear tooth vernier / involute checks)
5. Angle/flatness measurement: Sine bar/sine plate exercise and measurement of taper
6. Thread inspection with tool makers microscope.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Perform basic lathe machining operations.

CO2: Perform machining operations using conventional machine tools.

CO3: Analyze machine tool alignment and performance.

CO4: Evaluate components using metrology instruments.

CO5: Evaluate dimensional accuracy and inspection results.

Text Books:

1. P. N. Rao, *Manufacturing Technology: Metal Cutting & Machine Tools (Manufacturing Technology Vol. 2)*, 4th Edition, McGraw-Hill Education (2024)
2. R. K. Jain, *Engineering Metrology*, 22nd Edition (2024), Khanna Publishers — comprehensive metrology coverage, calibration and instrumentation.

Reference Books:

1. R.K. Jain, *Production Technology (Manufacturing Processes)*.
2. A. K. Ghosh & Mallik, *Manufacturing Science*, 2nd/3rd edition
3. S. Kalpakjian & Steven Schmid, *Manufacturing Engineering and Technology* (Testing & Materials Sections), 8th Edition, 2023, Pearson.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech II Year II Semester

25BAMECLC05 FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY

L	T	P	C
0	0	2	1

Pre-requisite: Fluid Mechanics

Course Description:

Laboratory course to validate and reinforce fluid mechanics and hydraulic machines theory through hands-on experiments. Emphasis on flow measurement, pressure-loss studies, pump/turbine performance testing, cavitation & efficiency evaluation, hydraulic jump and open-channel flows, instrumentation & calibration, data acquisition, uncertainty analysis, and industry-relevant reporting. Students will gain employable skills in test planning, instrumentation, performance evaluation, and technical reporting.

Course Objectives:

This course is designed to:

1. Give practical experience in measuring fluid properties and flow parameters (pressure, velocity, discharge).
2. Teach experimental procedures for verifying Bernoulli, continuity, momentum and energy loss relations.
3. Provide hands-on testing and performance evaluation of hydraulic machines (pumps & turbines).
4. Build skills in instrumentation, data acquisition, calibration and uncertainty estimation used in industry.
5. Train students to analyze experimental data, prepare industry-style test reports, and present findings.

List of Experiments

Fluid Mechanics Experiments:

1. Verification of Bernoulli's theorem
2. Determination of Coefficient of discharge of Venturi meter
3. Determination of Coefficient of discharge of Orifice meter
4. Determination of Coefficient of discharge of Turbine flow meter.
5. Determination of friction factor for a given pipeline.
6. Determination of loss of head due to sudden enlargement and contraction in a pipeline.

Hydraulic Machines Experiments

1. Performance test on Pelton wheel.
2. Performance test on Francis turbine.
3. Performance test on Kaplan turbine.
4. Performance test on centrifugal pump.
5. Performance test on reciprocating pump.

Wind Tunnel Experiments

1. Study on different aerodynamic shapes
2. Flow visualization of different objects using wind tunnel
3. Force measurement – Lift, Drag, Side force on different objects using wind tunnel

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Perform fluid flow measurement experiments.

CO2: Analyze discharge and head loss characteristics.

CO3: Evaluate pump and turbine performance.

CO4: Analyze aerodynamic characteristics of objects.

CO5: Design and demonstrate a fluid system experiment.

Text Books:

1. Y. A. Çengel & J. M. Cimbala, *Fluid Mechanics: Fundamentals and Applications*, 5th Edition, 2023, McGraw Hill.
2. R. K. Bansal, *A Textbook of Fluid Mechanics & Hydraulic Machines*, Revised Edition, 2022, Laxmi Publications.
3. P. N. Modi & S. M. Seth, *Hydraulics and Fluid Mechanics Including Hydraulic Machines*, 22nd Edition, 2023, Standard Book House.

Reference Books:

1. Frank M. White, *Fluid Mechanics*, 9th Edition, 2024, McGraw Hill.
2. J. F. Douglas, J. M. Gasiorek et al., *Fluid Mechanics*, 8th Edition, 2023, Pearson.
3. S. K. Som & G. Biswas, *Introduction to Fluid Mechanics and Fluid Machines*, 3rd Edition, 2021, McGraw Hill.

Mode of Evaluation: Continuous Internal Evaluation and End Semester Examination.

B. Tech II Year II Semester

25BAMECLC06 DYNAMICS AND VIBRATION ANALYSIS LABORATORY

L	T	P	C
0	0	2	1

Course Prerequisites Engineering Mechanics, Theory of Machines

Course Description:

The Dynamics and Vibration Analysis Laboratory introduces students to the experimental and computational study of mechanical systems in motion. The course covers force systems, rigid-body dynamics, balancing, governors, gyroscopic effects, vibration measurement, and system modelling. Hands-on experiments using MATLAB simulations, supported by conventional equipment, help students visualize dynamic response, validate theoretical results, and interpret vibration signatures.

Course Objectives:

By the end of this course, students will:

1. Provide hands-on exposure to dynamic and vibration characteristics of mechanical systems.
2. Enable students to perform MATLAB-based simulation, modelling, and validation for dynamic systems.
3. Develop an understanding of force systems, balancing, gyroscopic effects, governors, and vibration modes.
4. Train students to analyze vibration data and interpret system behaviour using plots, frequency response, and time-domain modelling.
5. Familiarize students with the fundamentals of damping, resonance, critical speeds, and stability.

List of Experiments:

1. MATLAB Simulation for Determining Acceleration due to Gravity Using a Virtual Compound Pendulum Model
2. Determine the Moment of Inertia of a Flywheel.
3. Gyroscopic effect and computation of gyroscopic couple using MATLAB
4. Watt governor dynamics and Equilibrium Speed Analysis
5. Performance Curves and Sensitivity analysis of Proell governor
6. Speed-Lift Characteristics of Porter governor
7. Dynamic Response and Stability Analysis of Hartnell governor using MATLAB
8. Analysis of Forced Vibration Response in a Single Degree of Freedom (SDOF) Spring–Mass System
9. MATLAB Simulation of Longitudinal vibration
10. MATLAB Modelling of Torsional vibration of single rotor shaft system
11. Torsional vibration of two rotor shaft system
12. Prediction and Visualization of Whirling speed of shaft
13. Determination of jump speed of cam-follower system

Course Outcomes:

The students after completing the course will be able to:

CO1. Apply principles of engineering mechanics to analyse force systems and rigid-body dynamics.
CO2. Model and simulate governors, gyroscopes, and rotor systems using MATLAB.
CO3. Perform vibration analysis using MATLAB for single and multi-degree-of-freedom systems.
CO4. Determine natural frequencies, damping characteristics, and response to harmonic excitation.
CO5. Predict critical speed and whirling behaviour of shafts using numerical techniques.

Text Book:

1. S. S. Rao, Mechanical Vibrations, Pearson Education, 6th Edition, 2017.
2. Holly Moore, MATLAB for Engineers, Pearson, 5th Edition, 2018.

Reference Book:

1. John Uicker, Gordon Pennock, Joseph Shigley, Theory of Machines and Mechanisms, Oxford University Press, 4th Edition, 2011.
2. Agam Kumar Tyagi, MATLAB and Simulink for Engineers, Oxford University Press, 2nd Edition, 2018.

Online Resources:

1. https://dom-nitk.vlabs.ac.in/
2. https://www.pvgcoet.ac.in/virtual-lab/

Mode of Evaluation: Continuous Internal Evaluation, Model Test and End Semester Examination

Skill Enhancement Courses

Skill Enhancement Course - I

25BAMECSC01 DATA SCIENCE FOR MECHANICAL ENGINEERS

L	T	P	C
1	0	2	2

Pre-requisite: Problem Solving using Python Laboratory, Scientific Computing Laboratory

Course Description:

This course equips Mechanical Engineering students with foundational and applied skills in data science, analytics, machine learning, and neural networks. Students work with real mechanical engineering datasets (vibration, machining, thermal systems, materials, fluid flow, etc.) and learn to clean, analyze, visualize, and model data using Python/MATLAB.

Course Objectives:

The objectives of this course are to enable the student to:

1. Introduce fundamental data science methods used in mechanical engineering.
2. Train students in preprocessing, visualization, and analysis of engineering datasets.
3. Enable learners to apply regression, classification, and clustering techniques.
4. Develop an understanding of artificial neural networks and modern deep-learning tools.
5. Provide practical exposure to Python/MATLAB-based data analytics workflows.

UNIT I INTRODUCTION TO DATA SCIENCE 9 hours

Role of Data Science in Mechanical Engineering, Types of Data: Numerical, Categorical, Time-Series, Sensor Data, Basics: Statistics, Probability, Mean, Median, Variance, Data collection in mechanical systems: sensors, DAQ systems, IoT Data cleaning, preprocessing, outlier removal, feature engineering.

Experiments:

1. Importing and cleaning mechanical engineering datasets (vibration, machining, thermal data) using Python/MATLAB.
2. Basic statistical analysis of engineering datasets (mean, variance, correlations).

UNIT II EXPLORATORY DATA ANALYSIS (EDA) & VISUALIZATION 9 hours

Data visualization using Matplotlib, Seaborn, MATLAB plots, Histograms, Box-plots, Scatter plots, Heatmaps, Correlation analysis and feature selection, Dashboard basics for engineering data, Visualization of manufacturing and vibration data.

Experiments:

3. Visualization of given CNC machining dataset - tool wear vs. cutting parameters.
4. EDA on vibration data for rotating machinery (FFT plots, time-series analysis).

UNIT III REGRESSION & PREDICTIVE MODELLING 9 hours

Introduction to Machine Learning, Types and Applications, Linear Regression, Polynomial Regression, Multiple Linear Regression for process modeling, Predictive modeling in manufacturing, thermal engineering, materials, Model evaluation: RMSE, R^2, cross-validation, Applications: Predicting tool wear, predicting material strength, thermal analysis.

Experiments:

5. Develop a regression model to predict tool wear using cutting speed, feed, and depth of cut.
6. Predict tensile strength or hardness from material composition using regression.

UNIT IV CLASSIFICATION & CLUSTERING FOR MECHANICAL SYSTEMS 9 hours

Classification: Logistic Regression, Decision Trees, SVM, Clustering: K-means, Hierarchical, Applications in mechanical engineering: Fault classification using vibration signals, Surface defects

classification (vision-based), Clustering of thermal cycles, tribology datasets, Dimensionality reduction: PCA.

Experiments:

7. Develop a classifier to detect bearing faults using vibration data (healthy vs. defective).
8. K-means clustering on thermal systems or machining performance datasets.

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9 hours

Basics of Artificial Neural Networks (ANNs), Benefits and limitations of ANNs, Applications of ANNs in Mechanical Engineering: Fault diagnosis, Tool wear prediction, Thermal system forecasting, Image-based defect detection, Multi-Layer Perceptron (MLP), Basics of Deep Learning, Convolutional Neural Networks (CNNs) for image-based inspection, Recurrent Neural Networks (RNNs) for time-series sensor data.

Experiments:

9. Implement a simple Multi-Layer Neural Network (MLP) to classify mechanical dataset samples (e.g., defective vs. non-defective machining parts).
10. CNN-based surface defect detection from images (small dataset).

Course Outcomes:

The students, after completing the course, will be able to:

CO1: Understand data types, data cleaning, preprocessing, and statistical analysis.
CO2: Perform exploratory data analysis and visualization for mechanical systems.
CO3: Apply regression and classification models to mechanical engineering datasets.
CO4: Use clustering and dimensionality reduction for data segmentation.
CO5: Understand neural networks and apply simple deep-learning concepts.

Text Books:

1. R.V. Rao, Data Science for Engineers, Springer, 1st Edition, 2022.
2. A. Mohan, Applied Machine Learning for Engineers**,** Wiley,1st Edition, 2021.
3. Jake VanderPlas**,** Python Data Science Handbook**,** O'Reilly, 2016.

Reference Books:

1. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn & TensorFlow, O'Reilly, 2nd Edition, 2019.
2. J. Carvill, Mechanical Engineering Data Handbook, Elsevier, 2nd Edition, 2018.
3. Holly Moore, MATLAB for Engineers, Pearson, 6th Edition, 2023.

Mode of Evaluation: Continuous Internal Evaluation , Assignments, Mid Term Tests and End Semester Examination.

Skill Enhancement Course - II

25BAMECSC01 MODERN MANUFACTURING SKILLS FOR MECHANICAL ENGINEERS

L	T	P	C
1	0	2	2

Pre-requisite: Manufacturing Processes, Manufacturing Technology & Metrology

Course Description:

This course provides hands-on exposure to modern manufacturing technologies including advanced welding and joining processes, CNC machining, and 3D printing, along with quality inspection and statistical tools. Students will learn manufacturing practice, defect identification, CNC programming, simulation, and quality analysis through structured lab exercises. The course is ideal for developing employable skills for shop-floor and industry-oriented roles.

Course Objectives:

The objectives of this course are to enable the student to:

1. Understand the principles and applications of advanced joining processes.
2. Acquire foundational knowledge of CNC programming, tooling, and machining operations.
3. Learn the workflow, materials, and process parameters used in 3D printing.
4. Perform basic fabrication tasks using CNC machines, welding setups, and 3D printers.
5. To train students in inspection, defect analysis, and statistical quality tools.

UNIT I ADVANCED JOINING PROCESSES 9 hours

Review of conventional welding (Arc, Gas, MIG, TIG), Introduction to advanced joining, Laser Beam Welding (LBW), Electron Beam Welding (EBW), Plasma Arc welding (PAW), Defects in welds & non-destructive testing (NDT).

Experiments:

1. TIG & MIG welding practice – bead formation & parameter study
2. Identification & Analysis of Welding Defects using Visual/Dye Penetrant Test (DPT)

UNIT II CNC MACHINING – BASICS, PROGRAMMING & TOOLING 9 hours

Introduction to CNC: structure, drives, control systems, Coordinate systems & machine axes, CNC turning and CNC milling basics, CNC tooling: inserts, tool holders, tool life, G-codes & M-codes Basic CNC part programming, Advanced G-codes, canned cycles (G70, G71, G73, G83), Work holding devices, Safety precautions.

Experiments:

3. CNC Turning Program with Canned Cycles (G70/G71)
4. CNC Milling – G-code generation for a pocket or slot

UNIT III CNC MACHINING – SIMULATION AND CAM 9 hours

CAD/CAM integration for machining, Toolpath generation (Contour, Pocketing, Facing, Drilling cycles), Introduction to Simulation software (Fusion 360, Mastercam, NX CAM), Parameters affecting CNC quality: spindle speed, feed rate, depth of cut, Surface roughness measurement & tool wear analysis, Introduction to industrial CNC automation & multi-axis machining.

Experiments:

5. CNC simulation – toolpath generation using Fusion 360°/CAM
6. G-Code Verification, Editing & Optimization using CNC Simulator

UNIT IV 3D PRINTING – PRINCIPLES, MATERIALS & PROCESSES 9 hours

Introduction to 3D printing, Comparison with subtractive manufacturing, 3D printing technologies: FDM, SLA, SLS, DMLS, 3D printing materials: PLA, ABS, PETG, Nylon, Resin powders, 3D printing workflow, Slicer settings: infill, support, layer height, print speed, temperature, Post-processing: sanding, curing, annealing, 3D printing defects.

Experiments:

7. Measurement of Dimensional Accuracy of a 3D Printed Engineering Components
8. Effect of slicing parameters on surface finish of a printed part

UNIT V QUALITY TOOLS 9 hours

Definition of quality, quality assurance, quality control, Need for quality in manufacturing industries Variability, defects, and process capability, Quality Tools (7 QC Tools): Cause-and-effect (Fishbone) diagram, Pareto chart, Control charts, Scatter diagram, Histogram, Stratification, Check sheets.

Experiments:

9. Welding defects analysis using check sheets and Pareto chart analysis
10. Dimensional Inspection of CNC-Machined Components & $\bar{X}$–R Chart Preparation.

Course Outcomes:

The students, after completing the course, will be able to:

1. Demonstrate understanding of advanced joining principles and applications.
2. Develop and execute basic CNC programs for turning and milling operations.
3. Explain and operate 3D printing systems for rapid prototyping.
4. Analyze the influence of parameters on joining, CNC machining, and 3D printing.
5. Apply modern quality tools for process improvement.

Text Books:

1. Larry Jeffus, Welding: Principles and Applications, Cengage Learning, 9th Edition, 2023.
2. P. N. Rao, Manufacturing Technology – Volume 2, Tata McGraw Hill Education, 4th Edition, 2018
3. Y. Kanetkar & P. Radhakrishnan, CNC Programming and Manufacturing, Routledge/Taylor & Francis, 2nd Edition, 2020.
4. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2nd Edition, 2021.

Reference Books:

1. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley, 7th Edition, 2021.
2. P. Radhakrishnan, S. Subramanyan & V. Raju, CNC Technology & Programming, New Age International Publishers, 2021.
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Mode of Evaluation: Continuous Internal Evaluation , Assignments, Mid Term Tests and End Semester Examination.